COMPLETE AIR BRAKE EXAMINATION QUESTIONS AND ANSWERS

WESTINGHOUSE - NEW YORK SYSTEMS

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A Standard Up-to-date Treatise for Enginemen and Students.

Explains in detail the construction and operation of all modern Air brake equipment, including the Westinghouse 8½ inch cross compound air pump, No. 6 E. T. Equipment, High Pressure Control Schedule U., K-Triple, L-Triple and L N Equipment, all Westinghouse Brake Valves, including the H-6 and S-6, also the 1¼ inch Pump Governor.

Compiled and Edited by the World's Leading Air Brake Experts

The New York Air Brake System is also clearly outlined and explained, every detail is made plain, including the Duplex Air Pump, Duplex and Triplex pump Governor, Automatic brake valve type L, Improved quick action Triple styles S-1 and H-1, also types J and K triple valves, B-2 and B-3 equipments. In fact all latest improvements and up-to-date appliances in air brake practice. Full instructions regarding the handling of trains.

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INTRODUCTION

The air brake undoubtedly stands at the head of the long list of appliances which today are considered absolutely necessary in the operation of railway trains; and when viewed from the standpoint of safety and convenience, it is bound to retain its position at the top.

The conclusion naturally follows that the construction and action of a device which occupies so prominent, and all important a place in railroading as does the air brake, must necessarily be of a more or less complicated nature; and such conclusion is well founded.

No other appliance connected with the running of trains requires the amount of study and skill on the part of the operator as does the modern air brake, with all the varied and improved devices which have from time to time been added to it, and those also which no doubt will be added in the future, as occasion demands.

Now regarding the best methods to be pursued in the study of so complicated a piece of mechanism as the air brake, opinions may differ, but there is one feature in the course of the aforesaid study which, owing to the requirements of modern railway examinations for promotion, cannot be neglected by the student who hopes to be successful. We refer to the catechetical form of study; the actual questions that will be asked by the examining board, and the correct answers to the same which will be required of the student. These will all be found in this volume, which contains in a condensed form

in addition a large amount of catechetical instruction in order to enable the student to thoroughly master the subject, and to make a creditable showing when called upon to appear before the examining board. For this reason there is included in the make-up of the book, a regular course of examination questions and answers pertaining to the subject, and the knowledge gained by a study of these will be of inestimable value to the student, and will prepare him to successfully pass any of the rigid examinations to which he may be subject while in the line of promotion.

Note.—The author gratefully acknowledges his indebtedness to the Air Brake Association for a portion of the subject matter contained in the following pages, particularly that pertaining to the examination questions and answers.

EXAMINATION QUESTIONS AND ANSWERS

Development of the Westinghouse Air Brake.

Q. What is a brake?

A. A device or mechanism for retarding or stopping rotation of the wheels of a vehicle.

Q. What is a power brake?

A. A brake in which the operating power is supplied by mechanical means such as compressed air, vacuum, hydraulic, or spring tension.

Q. What is a continuous brake?

A. A brake that works simultaneously on all the vehicles in a train.

Q. What is an air brake?

A. A brake operated by compressed air.

Q. What was the first or simplest form of air brake?

A. The "straight air" designed and invented by Mr. George Westinghouse, Jr., about 1869.

Q. Was this brake satisfactory?

A. It was not; in many respects.

Q. Give some of the principal reasons for its failure to give perfect satisfaction.

A. (1) If an accident happened to brake pipe or connections permitting the air pressure to escape, it could not be detected until the engineer attempted to apply the brakes, when the air would then escape at the damaged spot, and render the brake inoperative and useless. (2) The brake could only be applied at the engineer's valve on the engine. Third, on a long train of cars brake applica-

tion was too slow, the time required to get the air to the rear end of the train being so great that the stop was much longer than with a short train; likewise the time required to release the brakes on a long train was too slow, thereby causing delays in train starting. Fourth, as the supply of pressure for all brake cylinders of the train came direct from the engine, the longer the train the more cylinders there were to supply, and consequently the brake cylinder pressures would equalize lower on a long train than on a short train.

Q. What form of brake superseded the straight air brake?

A. The plain automatic brake, designed and invented by Mr. George Westinghouse, Jr., in the year 1873.

Q. Wherein was this brake an improvement over the "straight air" brake?

A. It was an indirect brake, being automatic in its action. Each car carried in an auxiliary reservoir its own storage supply of pressure for its brake cylinder, and the train pipe pressure, operating against a triple valve, held this storage of pressure from passing to the brake cylinder. Second, any accident to, or breakage of the brake pipe and its connections on the train or engine, was shown up at once by the brake applying. The automatic applying feature of this design of brake gave it great value. Third, as a reduction of pressure in the brake pipe would cause the brakes to apply, it was made possible for any of the train crew to apply the brake from any car in the train, equally as well as the engineer in his cab. Fourth, as pressure was stored in the auxiliary reservoir under each car for its individual use, that pressure could be passed into its brake cylinder much more quickly, with the automatic brake, than main reservoir

pressure on the engine could be sent back through the entire length of train pipe and into the cylinders of the whole train, by the straight air brake. Fifth, this feature of individual storage of braking pressure on each car made it possible to apply the brakes on a train of the ordinary length then hauled, almost as quickly as on a short train. Sixth, it also permitted as high pressures in the brake cylinders of a long train as on a short train.

Q. What were the objectionable features of the plain automatic brake?

A. While it gave satisfactory service on passenger trains and all freight trains of ordinary length, an emergency application on a long freight train, however, could not be made sufficiently sudden to prevent the slack of the rear portion of the train from running in and causing severe shocks to the cars and their lading on the rear end.

Q. When and by whom was a quicker-acting brake than the plain automatic demanded?

A. In 1887, by the Master Car Builders in their brake trials at Burlington, Ia., on the C., B. & Q. R. R. The fact was then and there developed that on long, 50-car freight trains the plain automatic brake set on the head cars first, and did not set sufficiently rapid to prevent the rear cars from running up against the forward portion of the train with such destructive force as to cause damage to the cars and their contents.

Q. Did this occur in the service application or the emergency application of the brakes?

A. Both, but with greater violence in the emergency application.

Q. What form of brake then superseded the plain automatic brake?

A. The quick action form, which grew out of the

Burlington brake trials. It was much quicker in its operation in emergency application and prevented the slack of the rear cars from running forward and doing damage to the lading and equipment of the train. The quick action brake has ever since been the standard brake in steam railroad service.

Q. The quick action form of brake gave a quicker emergency application; how did it operate in service application?

A. It operated in service application in the same harmonious manner as did the plain automatic brake, and operated independently of the emergency feature.

Q. What are the leading features of the quick-action triple valve?

A. First, the service feature, or part which calls into play only the piston, slide valve and graduating valve, in service application. Second, the emergency feature, or part which calls into play the emergency piston, emergency valve and rubber seated check valve, in addition to the piston and slide valve of the service feature.

Q. Have any other improvements been introduced in air brake practice since the development of the quick-action brake?

A. Yes; although the underlying principles of the brake proper remain; still many supplementary improvements have been added in recent years.

Q. Describe in brief the parts that comprised the straight air brake.

A. The air pump, the reservoir, the three way cock in the engineer's cab, for manipulating the pressure in and out of the brake pipe; the brake pipe, for conveying the air back to the brake cylinders, and the brake cylinder and its attachments under the car.

Q. How were brakes applied?

A. The engineer turned the three-way cock to a position which permitted reservoir pressure on the engine to pass back, through the brake pipe, into the cylinders under the cars. If a light application was desired only a small quantity of pressure was allowed by the engineer to pass from the reservoir to the brake cylinders. If it was desired to apply the brakes harder a larger quantity of air was permitted to pass through the three-way cock to the brake cylinders.

Q. How were the brakes released?

A. The position of the three-way cock handle was reversed by the engineer, cutting off reservoir pressure on the engine, and at the same time making a connection between the brake pipe and the atmosphere, thus permitting brake cylinder pressure to discharge through the brake pipe and three-way cock to the atmosphere. If a partial release was desired only a part of the pressure was allowed to escape at the three-way cock. If a full release was desired, all the pressure was permitted to be discharged from the brake cylinders and brake pipe, through the three-way cock, to the atmosphere.

THE WESTINGHOUSE AIR COMPRESSOR.

Q. What form of air compressor did George Westinghouse, Jr., first use in operating the air brake?

A. An old Worthington duplex water pump was converted and made to pump air.

Q. Describe in brief the construction and operation of the old style "trigger" or straight air pump.

A. This pump succeeded the Worthington. It consisted of a steam cylinder and air cylinder in vertical tandem. Steam entered the steam chest at the side, and sur-

rounded a valve which had a rotary motion imparted to it by "trigger" device in the top head operated conjointly by steam and the usual reversing slide valve rod extending down into the hollow piston rod. The operation of the air end resembled that of the later 6-inch pump.

Q. Briefly describe the action of the Westinghouse 6-inch air pump.

A. The action of the steam end is identical with that of the 8-inch pump. The action in the air end is as follows: On the up stroke, air is drawn in at the lower suction valve. On the same stroke, the atmospheric air in the air cylinder above the piston is compressed and forced out through the upper discharge valve to the main reservoir. On the down stroke, air is drawn into the upper end of the cylinder, through the upper suction valve, and the atmospheric air in the lower end of the cylinder is compressed and forced out through the lower discharge valve to the main reservoir. The steam pipe from the boiler is ½ inch in size; the exhaust pipe is ¾ inch, and the air discharge pipe is ½ inch. The suction pipe is 1¼ inch.

THE 8-INCH AIR PUMP.

Q. What end of the air pump is the power developed in to operate it?

A. The upper or steam cylinder end.

Q. What is the lower or air cylinder end for?

A. It performs the function of an air compressor.

Q. How many operative parts are there in the air end of the pump, and what are they?

A. Five; the air piston and four check valves, two of which are known as receiving valves and two as discharge valves.

Q. What performs the duty of compressing the air?

A. The air piston.

Q. Explain how this is accomplished.

A. As the piston is moving up or down in the cylinder, the air on one side of the piston is being compressed and delivered out to the main reservoir, while air from the atmosphere is flowing into the cylinder on the opposite side of the piston.

Q. Trace the flow of air in and out of the air cylinder.

A. Assume the piston to be on the up stroke. Air above the piston will be compressed, and forced out into a passage under the top discharge valve which would then be lifted off its seat and allow the air to pass out under pressure to the main reservoir, while at the same time air at atmospheric pressure would pass into and fill the lower part of the air cylinder by the unseating of the lower receiving valve. The piston having completed its up stroke, now starts down, at which moment the upper discharge valve, and the lower receiving valve both drop to their seats due to gravity. The air in the cylinder below the piston will now be compressed, and pass out through the lower passage, under the lower discharge valve which will be raised from its seat, thence out through the pipe connection to the main reservoir. At the same time atmospheric air is passing through the upper air inlets, filling the cylinder above the piston.

Q. What is the lift of the air valves in the 8-inch pump?

A. The receiving valves have $\frac{1}{8}$ inch lift and the discharge valves $\frac{3}{32}$ inch.

Q. Why is it necessary to give the receiving valves more lift than the discharge valves?

A. This is due to the construction of the pump. As all

valves are on one side, it is necessary to remove the receiving valves through the seats of the discharge valves, which necessitates that they be smaller in diameter, therefore require greater lift.

Q. What is the diameter of the steam and air cylinders of the 8-inch pump?

A. Steam cylinders, 8 inches. Air cylinders, 7½ inches.

Q. What is the stroke of the pistons in the 8-inch pump?

A. Nine inches.

Q. What operates the air piston of the pump?

A. The main piston in the steam end, which is directly connected with the air piston by the main piston rod.

Q. Describe in brief the steam end of the pump.

A. It is practically a small steam engine having a steam cylinder and piston, together with valves arranged to admit and exhaust steam to and from either side of the piston.

Q. How many operative parts are there in the steam end of the pump? Name them.

A. Five; the main steam piston, main valve, reversing valve, reversing rod and reversing piston.

Q. What is the duty of the reversing valve piston?

A. To assist the smaller main valve piston in overcoming the pressure under the larger main valve piston when moving the main valve to the lower position.

Q. What is the duty of the reversing slide valve?

A. To admit and exhaust the steam to and from the top of the reversing piston.

Q. What is the duty of the reversing valve rod?

A. To raise and lower the reversing slide valve.

Q. What is the duty of the main valve pistons?

A. To admit and exhaust the steam to and from the cylinder.

Q. Describe in brief the action of the steam when admitted to steam cylinder.

A. Steam entering the main valve chamber passes from thence through suitable openings into the reversing valve chamber, and, assuming this valve to be in the lower position, steam will pass into a chamber above the reversing piston. As the stem of this piston is resting on top of the main valve, this valve is forced to its lower position, owing to the combined areas of reversing piston and lower piston valve both of which have boiler pressure upon them, which overcomes the pressure under the upper piston valve. With the main valve in its lower position, the upper row of ports in the lower bushing are now open allowing steam to pass into the steam cylinder, under the steam piston forcing it up.

Q. When the piston reaches the end of its upward stroke, how is its motion reversed?

A. As it nears the end of the up stroke, the reversing plate attached to the top of the steam piston engages with the shoulder on the reversing rod and lifts the reversing valve to its upper position where the cavity in the valve connects two ports together allowing the steam above the reversing piston to pass to the atmosphere, while the live steam which is always between the two main valve pistons, now forces the main valve up, for the reason that the upper piston is larger than the lower. This upward movement of the main valve causes it to open the lower row of ports in the upper bushing, thus allowing steam to pass into the top end of the steam cylinder to drive the piston down, while at the same time the steam

that is under the piston is escaping to the atmosphere by way of the lower row of ports in the lower bushing, these being now open.

Q. What pressure is always present on the two inner faces of the main valve pistons?

A. Steam pressure from the boiler when the throttle is open.

Q. What pressure is always present on the two outer ends of the main valve pistons?

A. Exhaust or atmospheric pressure.

THE 9½-INCH AIR PUMP.

Q. Wherein does the 9½-inch pump differ from the 8-inch?

A. The 9½-inch pump has a much greater capacity, while the reversing valve gear in the steam end is much more simple. The air valves are differently located also.

Q. What side of the pump are the receiving valves located on?

A. On the left side, or side the air inlet is on.

Q. What side of the pump are the discharge valves located on?

A. On the right side, or side the discharge pipe is on.

Q. What is the difference between a "right hand" pump and a 'right and left hand' pump?

A. The 'right hand' pump has but one steam supply connection which is on the right side of the cylinder, and a single exhaust connection which is on the left side of the cylinder. The "right and left hand" pumps, however, have a steam supply connection and an exhaust connection on each side of the cylinder.

Q. In piping up a pump how can the steam supply

connection be distinguished from the exhaust connection?

A. The steam supply connection is the lower one, on either side, and is a smaller pipe connection than the exhaust.

Q. What are the dimensions of the 9½-inch pump?

A. Nine and one-half inch bore, by 10-inch stroke.

Q. Name the operative parts of the steam end of this air pump.

A. Main steam piston; main slide valve; differential pistons and connecting rod; reversing slide valve; and reversing valve rod.

Q. What kind of a valve controls the admission and release of the steam to and from the steam cylinder?

A. A slide valve of the D type.

Q. Where do the three ports in the slide valve seat lead to?

A. One leads to the lower end of the steam cylinder (lower admission port); one leads to the upper end of steam cylinder (upper admission port); and the middle port is the exhaust.

Q. What is the duty of the reversing valve rod?

A. To raise and lower the reversing slide valve.

Q. What is the duty of the reversing slide valve?

A. To admit and exhaust steam to and from the chamber on the right of main valve piston.

Q. What is the duty of the differential pistons and connecting rod?

A. To actuate or move the main slide valve over the ports in its seat.

Q. What is the duty of the main slide valve?

A. To admit and exhaust steam to and from the pump cylinder.

Q. What is the duty of the steam piston?

A. To operate the air piston in the air cylinder.

Q. Explain the passage of the air through the air end of the 9½-inch pump.

A. Assuming the piston to be on the up stroke, the air in the cylinder above the piston will be compressed and forced out through the upper passage under the upper discharge valve, unseating this valve and passing by it into the outer chamber, and thence out through the discharge pipe connection to the main reservoir. At the same time atmospheric air is passing through the air inlet, unseating the lower receiving valve, and passing into the air cylinder filling the space underneath the air piston. The action of the pump on the down stroke is similar to that of the up stroke, with the exception that in this case the lower discharge valve is delivering the air, while the upper receiving valve is admitting air at atmospheric pressure.

Q. How many working parts are there in the air end of the 9½-inch pump?

A. Five; the air piston; and four check valves, of which two are receiving, and two discharging valves.

Q. What is the lift of the air valves in the 9½-inch pump, and are they interchangeable?

A. The lift is $\frac{3}{32}$ inch. They are interchangeable.

Q. When the piston on the downward stroke has reached the bottom, how is its motion reversed?

A. The reversing plate on the piston strikes the knob on the end of the reversing valve rod pulling it down, thus moving the reversing slide valve down until two ports in the seat are connected. One of these ports leads to the chamber back of the larger differential piston, and the other leads to the main exhaust port. Pressure being

now removed from behind the larger piston, it is free to be moved to the right by the live steam pressure, and in doing so it carries the smaller piston with it, and also the main slide valve, and thus reverses the pump.

Q. What is the function of the small port leading to the chamber above the reversing valve rod in the cap nut?

A. This is to prevent pressure from accumulating above the reversing rod which would prevent it from reversing properly. It is connected at all times with the upper end of the steam cylinder, therefore, contains no pressure when the piston is on the up-stroke.

Q. Of what use are the small cocks?

A. They are drain cocks and should be open at all times when the pump is not running to prevent condensation from accumulating in the steam cylinder and passages.

Q. How should the air pump be started?

A. Slowly, to allow the condensation to escape from the steam cylinder and to accumulate sufficient pressure in the air cylinder to form a cushion for the piston.

Q. How much air pressure is required to do this?

A. About twenty-five or thirty pounds should be sufficient.

Q. What else should be done at the same time that the steam throttle to the pump is opened?

A. The lubricator should be started feeding freely at first, until the pump has received eight or ten drops of oil; the feed should then be reduced to what may be considered proper.

Q. When should the air cylinder be oiled, and what kind of oil should be used?

A. The air cylinder should be lubricated with a small

amount of oil at frequent intervals. Valve oil should be used, as it has a good body and will stand the temperature of the air cylinder.

Q. Should oil ever be introduced through the air inlets?

A. No; such oiling has a tendency to gum up the air valves and passages and does the cylinder very little if any good.

Q. How tight should the pump be packed?

A. Just tight enough to prevent blowing.

Q. How should the pump be run in descending grades?

A. With the pump throttle well open.

Q. How should it be run at other times?

A. Fast enough to maintain the full pressure and allow the pump governor to stop it once in a while, but it should not be run with a wide open throttle unless necessary to keep up the full pressure.

Q. Should coal oil, or what is termed carbon oil or kerosene, ever be used to clean out or oil a pump?

A. No; it is dangerous to use it if the pump is warm, and it does not clean it as thoroughly as other more suitable materials.

Q. What should be considered as the maximum speed to run the pump?

A. Not to exceed 120 single strokes per minute.

Q. Why is a higher speed detrimental?

A. It may not allow the cylinder to be filled with air at each stroke, and would eventually cause the pump to run hot.

Q. What benefit is a well oiled swab on the pump piston rod?

A. It keeps the piston rod packing lubricated, greatly

prolonging the life of same, as well as assisting in lubricating the cylinders.

Q. From what point of the boiler should the pump receive its steam?

A. From some high point, where dry steam can be had.

THE 11-INCH AIR PUMP.

Q. In what respect does the 11-inch pump differ from the 9½-inch pump?

A. Principally in size, although a number of decided mechanical improvements have been made in the construction.

Q. In what respect does the operation of the 11-inch pump differ from the 9½-inch pump?

A. There is no difference whatever, the same simple valve gear is used in the 11-inch pump that has been described in the 9½-inch pump.

Q. What is the lift of the air valves in the 11-inch pump?

A. Three thirty-seconds of an inch, or the same as the 9½-inch pump.

Q. Are the air valves of the 11-inch pump interchangeable with the 9½-inch pump valves?

A. No; while the valves in each pump have the same lift, they are not interchangeable, as the 11-inch pump valves are larger in diameter.

Q. What is the comparative efficiency of the 11-inch pump and 9½-inch pump?

A. Operating under similar conditions the 11-inch pump is about 30 per cent. more efficient than the 9½-inch pump.

Q. What is the size of the steam and air cylinders of the 11-inch pump?

A. The steam and air cylinders are both 11 inches in diameter.

Q. What is the stroke of the pistons in the 11-inch pump?

A. Twelve inches.

Q. What points should be observed in reference to the operation and care of the 11-inch pump?

A. The same general rules as apply to the 9½-inch pump should be followed in reference to the 11-inch pump.

THE TANDEM COMPOUND AIR PUMP.

Q. What is the leading feature of the Westinghouse tandem compound air pump?

A. Two stages of air compression between the time of admission, and time of discharge to main reservoir.

Q. Is the steam compounded also?

A. It is not; the single steam cylinder is similar to that of the 9½ and 11-inch pumps.

Q. Compared with the 9½ and 11-inch pump, what is the leading feature of the Westinghouse tandem compound air pump?

A. While it has a steam cylinder of only 8 inches in diameter, it has an air compressing capacity equivalent to the 11-inch pump.

Q. What other peculiarity is there about this air pump?

A. While its steam cylinder is internally the same as that of the standard 8-inch pump, it has the valve gear mechanism and pipe connections of the special 9½-inch pump.

Q. Describe the arrangement of cylinders of the tandem compound pump.

A. There are three cylinders placed vertically in tandem, the top one or steam cylinder being joined to the two lower, or air cylinders by a center piece, while the air cylinders are united by a thin center piece or partition through which works the drum that unites the two air pistons.

Q. Describe the action of the pump in compressing air.

A. Assuming the pistons to be on the down stroke, air passes in through the upper air inlet on the left hand side, lifts the upper receiving valve, and passes into the upper cylinder filling the space above the descending piston. When the piston has completed the down stroke and moves up this air is compressed, and lifting the upper discharge valve (upper right hand side of cylinder), is forced out past the upper discharge valve, which is also now a receiving valve for the higher pressure compartment, which is the annular cavity between the piston drum and the cylinder. Since the volume of this compartment is much smaller than the low pressure volume of the cylinder from which it was received, this air is being compressed during its passage from the low pressure to the high pressure volumes, until when the piston reaches the upper end of its stroke the air in the low pressure clearances, passages and high pressure volume has reached the intermediate pressure of approximately 40 pounds.

Q. Describe the further action of the pump.

A. During the second down stroke of the piston this intermediate pressure air is further compressed until it lifts the final discharge valve, and passes out through the air discharge orifice in the center piece, and thence to the main reservoir.

Q. When air is taken at the lower end of the cylinder what takes place?

A. The same operation occurs in the lower cylinder when the piston goes in the opposite direction from that described above, and as corresponding passages are designated by the same letter the operation can be readily followed.

Q. How is the air cylinder lubricated?

A. The air cylinder is lubricated by three oil cups. The upper end receives its oil from that cup placed just to the left on the upper center piece. The piston drum receives its lubrication by the oil from the cup connecting with a passage in the upper air cylinder and is drawn into the high pressure volume of the air as it goes from the low pressure to the high. The lower end of the air piston is lubricated by the oil cup situated on the left side of the lower center piece.

Q. Why is the compound pump equal to the 11-inch air pump in air compression capacity when provided with an 8-inch steam cylinder?

A. This results from the compound feature of the air cylinders. As already explained, when the pistons are moving upward, air is being forced from the cylinder above the piston to the annular cavity between the drum portion of the piston and the cylinder, the air gradually increasing in pressure as the piston advances, reaching a pressure of about 40 pounds at the termination of the stroke. This pressure under the piston and above the center piece exerts an upward force on the piston the same as does the steam under the steam piston, while at the same time the air under compression to the main reservoir is exerting only a resistance equal to the area of that portion of the upper side of the air piston ex-

posed to the air being compressed in the annular opening between the piston trunk or spool and the cylinder.

Q. Does this result in economy?

A. Yes; by compounding the air end a much smaller steam cylinder can be used to operate the pump, thus causing a marked economy in steam consumption.

AIR PUMP GOVERNOR.

Q. What is the function of the pump governor?

A. To regulate the supply of steam to the pump in such a manner that the speed of the pump will maintain the desired pressure.

Q. Describe the connections of the single top governor.

A. There are three; one to the boiler; one to the pump, and one to the main reservoir.

Q. Does the main reservoir connection always lead to the main reservoir?

A. No; with the D-8 brake valve this connection leads to the train pipe.

Q. Name the valves in the single top governor.

A. There are two; the steam or throttle valve, and the air valve, or pin valve.

Q. Name the other important parts of the governor.

A. The piston, which actuates the steam valve, the adjusting spring and the compressing spring, also the diaphragm.

Q. Describe the action of this governor.

A. With the governor open, which is its normal position, air pressure enters the governor at the main reservoir connection, and passes into a chamber below the diaphragm, this pressure increasing until it exceeds the tension of the adjusting spring above the diaphragm,

when the latter will yield and cause the pin valve to be raised from its seat. The air is now free to pass into the chamber above the governor piston which it forces down compressing the spring and seating the steam valve.

Q. When the pressure beneath the diaphragm is reduced below that for which the governor is adjusted, what will take place?

A. The tension of the adjusting spring will cause the diaphragm to move down, and seat the pin valve.

Q. With the pin valve seated, what will cause the steam valve to again open and supply steam to the pump?

A. The chamber above the governor piston is always open to the atmosphere through a small relief port, through which the air pressure above the piston may be relieved, thus allowing the spring, with the assistance of the steam pressure under the valve to raise the piston and valve to their normal positions which will again start the pump to work.

Q. What is the function of the Westinghouse duplex pump governor?

A. To permit of controlling the pump with two different air volumes, or a ready change in the pump control, from one pressure to another, without the necessity of re-adjusting the governor.

Q. In what respect does this governor differ from the single-top governor?

A. The only difference is in the upper or air end; two diaphragm portions are used, and a siamese fitting, by which they are connected to one steam portion of the governor.

Q. Is the principle of operation of this device the same as the single-top pump governor?

A. Yes; the description of the operation of the single-top governor covers this device.

Q. Do both of the diaphragm portions operate it at the same time?

A. No; as the adjustments of the heads differ, it requires different pressures to operate them; therefore, only one head operates at one time.

Q. Does it make any difference what head is set for the high or low pressure?

A. No; not as far as the governor is concerned. This is governed entirely by the way the heads are connected up.

Q. By referring to the vent ports in the siamese connection, it will be seen that one is to be plugged. What is this for?

A. To prevent a needless waste of air. As the siamese fitting directly connects both diaphragm portions together, one vent port is sufficient, as only one head is operating at one time.

Q. What equipments is the duplex pump governor used with?

A. The High Speed Brake, "Schedule U," or High Pressure Control, and the Duplex Main Reservoir Control.

Q. During the time the pin valve is unseated there is a continuous blow from the relief port. What is this for?

A. This leakage, in conjunction with the flow of steam through the small port in the steam valve serves to keep the pump working slowly, to avoid the accumulation of condensation.

Q. What is the purpose of the connection from below the governor piston to the atmosphere?

A. This is the drip pipe connection to the chamber immediately below the piston, for the purpose of permitting any steam that may leak past the steam valve, or any air that may leak past the piston, to escape to the atmosphere.

AUTOMATIC LUBRICATION.

Q. What is the object of the automatic air cylinder oil cup?

A. To automatically lubricate the air cylinder of the air pump, instead of by hand.

Q. In what manner does the automatic cup better perform the lubrication of the pump than a hand oiler?

A. With the hand oiler, a considerable quantity of oil is given the pump at one time to last the entire trip, while the automatic oil cup is subject to alternate suction and compression strokes of the air piston, and just the required amount of oil is regularly and continuously fed to the air cylinder.

Q. Describe the construction and operation of the No. 1 automatic oil cup.

A. It consists of a brass body having an internal chamber in which the oil is placed. A small regulating valve stem passes down through this chamber. This valve stem can be adjusted from the top by simply pulling off the cap which fits into the top of the body. A small lock nut on this valve stem, guards against the feed adjustment changing. When the valve is slightly raised oil passes drop by drop into the small chamber below. This chamber connects through a passage to the cap, and by means of small holes in this cap to the atmosphere, thus bringing said chamber always under atmospheric pressure.

Q. What is the function of the ball valve in the lower part of the cup?

A. When the air piston descends, the suction causes this valve to rise, and the air will pass through the holes in the cap and by way of the passage into the body, and as this air passes on into the pump cylinders, any oil that may have dropped from the regulating valve onto the top of the nut holding the ball valve in position, is drawn into the pump cylinder, thus lubricating it. As soon as the piston starts on the return, or up stroke, the ball valve promptly seats itself, thus preventing any air from being discharged to the atmosphere through the oil cup.

Q. What is the purpose of the four holes drilled up through the cup?

A. These holes connect with a circular groove in the base, and are thus connected with each other. This groove also connects with the passage leading from the pump cylinder to the top of the ball valve, and during the up stroke of the air piston, compressed air is forced into the grooved canal in the base, and thence to the vertical drilled holes or passages in the body, and as the temperature of compressed air is always sufficiently high to heat the oil cup the oil is thus kept liquid even in cold weather.

Q. Describe the construction and operation of the No. 2 automatic oil cup.

A. This cup is composed of a steel base screwing into the air cylinder of the air pump, to which is connected a brass oil reservoir. A brass cap fits the top snugly. Oil is contained in the inner chamber. The operative parts are a valve, valve spring and needle feed stem. On the down stroke of the air piston the valve is drawn from its seat by suction, compressing the spring, a slight

amount of air is drawn in to the cup, and oil is drawn past the needle and down into the air cylinder. The temperature of the oil in the cup is kept warm by the same means as in No. 1, that is, the admission of warm air to passages cast in the body.

Q. What is the principal difference between this cup and No. 1 cup?

A. No. 1 has an adjustable feed, while No. 2 has a fixed feed.

PUMP GOVERNOR DISORDERS.

Q. If trouble is experienced in the regulation of main reservoir pressure how may the engineer ascertain whether or not the defect is in the steam or air portion of the governor?

A. By examining the vent port of the governor. If it is found to be open and air flowing freely from it, it indicates that the air end of the governor is all right and that the trouble must be in the steam end. Something is preventing the piston from seating the steam valve.

Q. If this trouble is experienced on a day when the weather is very cold, where would we usually find the trouble?

A. The drain or waste pipe is probably frozen up.

Q. Is that the only defect that could cause such a trouble?

A. No; a blind gasket in this pipe, or the pipe clogged with dirt or gum or otherwise closed, would cause it. This allows the steam that may leak by the stem of the steam valve to accumulate under the piston, holding it up against the air pressure above it.

Q. Sometimes a governor that has been working prop-

erly will develop a continual blow from the vent port. What would be defective in this case?

A. The diaphragm valve would be unseated in this case, probably due to dirt or foreign matter on its seat.

Q. Should the vent port be plugged to prevent the loss of air?

A. No; to do so would probably cause the governor to stop the pump. As the diaphragm valve would continue to leak, and as there would be no outlet for the air, it would accumulate above the piston until there was sufficient to drive it down, which would stop the pump.

Q. If the governor stops the pump properly, but fails to start it again when the pressure is slightly reduced, what may cause the trouble?

A. The diaphragm valve being rigid, instead of having the proper amount of side play, a partly or entirely stopped-up vent port, or the piston packing ring being a very tight fit and stuck in the lower end of the cylinder.

Q. How does the rigid diaphragm valve cause such trouble?

A. By not seating properly it allows air pressure to feed down on top of the piston holding it down.

Q. How should the packing ring fit the cylinder?

A. It should be a neat working fit and as near air tight as possible, as leakage by this ring would be a waste of air, and would have a similar effect as an enlarged vent port.

Q. Some governors are observed to have a heavy flow of steam from the waste pipe at all times. What would cause this?

A. The piston stem being a very loose fit, and the upper side of the steam valve not making a very good joint.

Q. What is the standard main reservoir pressure on

grades less than one and one-half per cent? On grades of one and one-half per cent and over?

A. Ninety pounds and 110 pounds.

Q. Where duplex governors are used, what should be the difference in adjustment of the two heads as regards pressure?

A. Twenty pounds.

Q. What is the allowable variation of the governor in controlling pump?

A. Theoretically there should be no variation.

GAUGES.

Q. What is the purpose of the different air gauges used on the engine?

A. To properly indicate the air pressures in the different parts of the brake system.

Q. What pressure does the red hand on the duplex gauge indicate? What pressure does the black hand indicate?

A. Red hand—main reservoir; black hand—chamber "D" pressure.

Q. Where duplex gauge is used on brake cylinder, as with No. 6 E T equipment, what does red hand indicate? What does black hand indicate?

A. Gauge No. 1. Red hand, main reservoir pressure; black hand, equalizing reservoir pressure.

Q. What pressures are indicated by Gauge No. 2?

A. Red hand, brake cylinder pressure; black hand, brake pipe pressure.

Q. Which gauge hand shows the amount of reduction being made during a service application of the brakes?

A. Black hand, Gauge No. 1.

Q. Why, then, is the black hand of Gauge No. 2 necessary?

A. To show brake pipe pressure when engine is second in double-heading or a helper.

Q. What pressure is indicated by the red hand of Gauge No. 2 when operating the automatic or independent brake valve?

A. Brake cylinder pressure.

Q. How can you test principal air gauge to prove probable correctness?

A. By means of a test gauge attached to train pipehose on tender. Place brake valve in full release for the red hand, and in running position for the black hand.

THE WESTINGHOUSE 8½-INCH CROSS-COMPOUND AIR COMPRESSOR.

Q. What are the principal advantages of this compressor as compared with all other types of locomotive air compressors?

A. Economy in steam consumption and great air compressing capacity.

Q. Explain in a general way the design of the 8½-inch cross-compound compressor as compared to the 9½-inch and 11-inch Westinghouse compressors.

A. It has two steam and two air cylinders placed side by side, the steam cylinders vertically above the air cylinders and joined by a suitable center piece.

Q. How are the steam cylinders designated?

A. High and low pressure steam cylinders.

Q. How are the air cylinders designated?

A. High and low pressure air cylinders.

Q. What are the dimensions of the steam cylinders?

A. The high pressure steam cylinder is 8½x12 inches, the low pressure steam cylinder, 14½x12 inches.

Q. What are the dimensions of the air cylinders?

A. The low pressure cylinder is 14½x12 inches; the high pressure air cylinder, 9x12 inches.

Q. Why do the high pressure cylinders vary in diameter, while the low pressure cylinders are of the same size?

A. In view of the boiler pressure being greater than the maximum air pressure desired, it does not require a high pressure steam cylinder as large in diameter as the high pressure air cylinder. This permits of greater economy in steam consumption and more uniformly balances the steam and air forces acting on the various pistons.

Q. How are the cylinders relatively located?

A. The low pressure air cylinder is under the high pressure steam cylinder; the high pressure air cylinder is under the low pressure steam cylinder.

Q. How are the high pressure steam piston and low pressure air piston joined?

A. By a hollow piston rod, the same as those in 9½ and 11-inch compressors.

Q. How are the low pressure steam piston and the high pressure air piston joined?

A. By a solid piston rod.

Q. Have the low pressure steam piston and the high pressure air piston and rod any mechanical connection to the valve gear?

A. No; they are simply floating pistons.

Q. How many inlet valves has the low pressure air cylinder?

A. Four.

Q. Where are they located?

A. Two each in the top and bottom heads of the cylinder.

Q. How many intermediate valves?

A. Four.

Q. What is the purpose of the intermediate valves?

A. They perform the same duties between the low and high pressure air cylinders as the discharge valves do between the high pressure air cylinder and the main reservoir.

Q. Where are they located?

A. Two each in the top and bottom heads of the low pressure air cylinder.

Q. How many discharge valves has the high pressure air cylinder?

A. Two.

Q. Where are they located?

A. Outside of and near the top and bottom of the high pressure air cylinder.

Q. Where is the steam valve gear located?

A. In the top head of the high pressure steam cylinder.

Q. Does a single valve mechanism serve to operate the entire compressor?

A. Yes.

Q. What are the operative parts of the valve gear?

A. A piston valve, reversing valve and reversing valve rod.

Q. How many pistons has the piston valve?

A. Five.

Q. What are the purposes of the five pistons?

A. The two outer or differential pistons perform the same duties, and in the same way, as the main valve pistons of the 9½-inch compressor. The three intermediate pistons, all of equal diameter, govern the flow

of steam through the admission and exhaust ports of the steam cylinders, thus corresponding to the main (slide) valve of the 9½-inch compressor.

Q. How many steam ports are there in the piston valve seat?

A. Five.

Q. To what do they connect?

A. Beginning at the right-hand port, the ports connect to the steam cylinders as follows: the top of high pressure cylinder; top of low pressure cylinder; exhaust; bottom of low pressure cylinder, and bottom of high pressure cylinder respectively.

Q. Name the operating parts of the compressor.

A. The reversing valve and the reversing valve rod; the piston valve, which performs the same duties as the differential pistons and slide valve of the 9½-inch compressor; the inlet valves, the intermediate valves, in the pasages connecting the high and low pressure air cylinders; the discharge valves; the high pressure steam piston and its rod; the low pressure steam piston and its rod; the low pressure air piston, and the high pressure air piston.

Q. How does the piston valve perform the same duties as the differential pistons and main (slide) valve of the 9½-inch compressor?

A. The five pistons are so arranged that the two outer (differential pistons) when moved actuate or move with them the three intermediate ones over the ports in their seat, permitting the passage of steam to and from the cylinder ports in a similar way to that accomplished with the slide valve.

Q. Where is the steam pipe connection to the compressor?

A. At the steam inlet, at the right of the high pressure steam cylinder.

Operation, Steam Portion.

Q. Where does steam enter the compressor?

A. Through the passage leading to the top head to main valve chambers; also through the port into the chamber containing reversing valve.

Q. What is the duty of the reversing valve?

A. To admit and exhaust steam from the chamber, at the right of the piston valve.

Q. When the high pressure steam piston is at the bottom of its stroke, what position will the reversing valve be in?

A. Down.

Q. In what position is the low pressure steam piston at this time?

A. Up.

Q. Do the high and low pressure pistons always move in opposite directions and at the same time?

A. Yes.

Q. With the reversing valve down, what takes place?

A. The chamber at the right of the piston valve is open to the exhaust through a port, and cavity in reversing valve, and exhaust port. The larger piston of the piston valve having a greater area exposed to the pressure in the chamber than the smaller piston at the opposite end of the piston valve, moves the piston valve to the right.

Q. With the piston valve in the position just described, what takes place in the steam cylinders?

A. With steam pressure from the boiler always present in the main valve chambers, steam is admitted to the

bottom end of the high pressure steam cylinder, from the chamber on the left, carrying its piston upward; at the same moment the steam in the top end of the high pressure cylinder is expanding into the top end of the low pressure cylinder, forcing its piston downward. During the down stroke of this piston, the bottom end of the low pressure cylinder is open to the exhaust.

Q. Upon completion of the piston stroke just described, what takes place?

A. As the high pressure piston approaches the upper end of its stroke, the reversing plate strikes the shoulder on the reversing valve rod, forcing it and reversing valve upward. This movement closes the port to the exhaust and uncovers another port, allowing steam to flow to the chamber at the right of the larger piston valve. Since live steam is always in the top chambers, and exerts its pressure against the inner surfaces of the largest and smallest of the piston valve pistons, and since now the larger piston has full steam pressure on its outer face, the resulting pressure on it will be balanced, while the small piston has steam on its inner face, and the chamber on its outer face is open to the exhaust, there is an unbalanced pressure on the right of the small piston so that it will be forced to the left.

Q. What follows the movement of the piston valve to the position just described?

A. Steam is admitted to the top end of the high pressure cylinder from the chamber on the right, driving its piston downward. At the same time, the steam under the high pressure piston expands into the bottom end of the low pressure cylinder, carrying its piston upward. The top end of the low pressure cylinder is now open to the exhaust.

Operation, Air Compressor Portion.

Q. How is the air taken into the bottom end of the low pressure air cylinder?

A. When the high pressure steam piston is moved upward, the low pressure air piston, being connected to the same piston rod, is also carried upward, and air is drawn in through the lower strainer into the lower passage; the lower inlet valves lift and the air passes into the cylinder through inlet ports.

Q. While this is going on, what is taking place in the top end of the low pressure air cylinder?

A. Air above the piston is being compressed during its upward movement and forced past the upper intermediate valves, through a passage into the top end of the high pressure air cylinder, the piston of which is meanwhile traveling downward.

Q. What takes place in the bottom end of the low pressure cylinder when the piston reaches the upper end of its stroke?

A. When the piston starts downward, the inlet valves are forced to their seats, and the air below the piston is compressed until it can raise the lower intermediate valves against the air pressure in the high pressure cylinder acting on their upper side, when it is forced through ports to the lower end of the high pressure air cylinder, the piston, in the meantime, being drawn upward by steam pressure under the low pressure steam piston.

Q. What takes place in the top end of the low pressure air cylinder at this time?

A. The upper intermediate valves drop to their seats and prevent back flow of air from the top end of the

high pressure air cylinder, and air is drawn through the upper air strainer into a passage past the upper inlet valves—and through a port into the top end of the low pressure air cylinder. At the same time the high pressure air piston is moving upward (compressing the air admitted from the top end of the low pressure air cylinder to the top part of the high pressure air cylinder), until its pressure in the passage is sufficient to lift the upper discharge valve against the main reservoir pressure holding it to its seat, and air then flows through passages to the air discharge and the main reservoir.

Q What takes place when the low pressure air piston reaches the lower limit of its stroke and starts upward?

A. The lower intermediate valves drop to their seats so that air from the high pressure air cylinder cannot flow back into the low pressure air cylinder; at the same time the high pressure piston is forced downward by the low pressure steam piston, compressing the air (that has been forced into the high pressure air cylinder from the low pressure side), lifting the discharge valve, when it will be forced through port and passage to the air discharge and main reservoir.

Q. It has been stated that the high pressure piston is forced downward by the low pressure steam piston. Is there any additional force exerted on the piston at this time?

A. Yes. During the time the high pressure air piston is moving down the low pressure air piston is moving up and compressing the air into the upper end of the high pressure air cylinder. The gradual increase of air pressure on top of the piston exerts a downward force on the piston the same as does the steam above the low pressure steam piston. When the compressor mechan-

ism is reversed, the action is simply a repetition of that just described.

Q. What pressures are exerted on the pistons as they reach the lower end of the stroke?

A. Steam piston has from 25 to 40 pounds of steam pressure per square inch (dependent upon boiler pressure) and air piston about 40 pounds of air pressure.

Q. What is the intermediate air pressure on the under side of the high pressure air piston as it starts on its downward stroke?

A. About 40 pounds.

Q. What is the pressure on the piston when it starts on its upward stroke?

A. The same; about 40 pounds.

Q. In how many stages is the air compressed?

A. Two.

Q. What is meant by "two stages"?

A. The final pressure at which the air leaves the compressor is obtained by two separate compressions. The first "stage" is when air, at atmospheric pressure, in the low pressure air cylinder is compressed and delivered to the high pressure air cylinder at the "intermediate" pressure. The second stage is when the air at the intermediate pressure in the high pressure air cylinder is compressed, and delivered to the main reservoir at the final or high pressure.

Q. What type of air valves are used in the 8½-inch cross-compound compressor?

A. Inlet valves and discharge valves are of the 11-inch compressor standard. Intermediate valves are of the 9½-inch compressor standard.

Q. What is the lift of all air valves?

A. $\frac{3}{32}$ inch.

Q. How can the air inlet valves be removed?

A. Top valve is accessible by removing cap nuts, and bottom one by removing the valve cages.

Q. How are the upper intermediate valves removed?

A. By taking out the cap nuts.

Q. How are the lower intermediate valves removed?

A. By unscrewing valve cages.

Q. How are the discharge valves removed?

A. By removing cap nut and by taking out valve cage.

Q. What provision is made for lubricating the piston rods of the compressor?

A. Swabs, which should be kept well lubricated with oil.

Q. How many oil cups has the compressor, and where are they located?

A. Two; located on the high pressure steam cylinder head.

Q. What do they lubricate?

A. One the high pressure air cylinder; the other the low pressure air cylinder.

Q. How many drain cocks has the compressor, and where are they located?

A. Four; located in the steam cylinders.

Q. What is their purpose?

A. The ¼-inch cock drains the steam inlet chamber; the other cocks drain the top and bottom ends of the low pressure steam cylinder and the bottom end of the high pressure steam cylinder.

Q. When should these drain cocks be open?

A. At all times when the compressor is not running, to prevent condensation from accumulating in the cylinders and passages, and when starting it.

Q. In general, how should this compressor be operated?

A. The same as the older standard Westinghouse compressors.

Q. What decided advantages has the cross-compound as compared to other types of locomotive air compressors?

A. (a) Economy in steam consumption.
(b) Great air compressing capacity at comparatively low speed.
(c) The compressor is less susceptible to pounding and strains incident thereto.
(d) Less packing ring leakage in both the steam and air cylinders.

Q. What contributes largely to the steam economy?

A. Compounding the steam, and less low packing ring leakage.

Q. What contributes largely to air capacity?

A. A low maximum pressure in the low pressure air cylinder; less differential pressure on opposite sides of the pistons, as compared to older types of air compressors, and full stroke of high pressure steam and low pressure air pistons, and valve gear, regardless of high or low main reservoir pressure.

Q. Why is the packing ring leakage less in the low pressure air cylinder?

A. Because, as already explained, the pressure in this cylinder never exceeds 40 pounds.

Q. Why is the packing ring leakage less in the high pressure air cylinder?

A. As the air is compressed to main reservoir pressure on one side of the piston, it is being built up to about 40 pounds on the other side (a result of compress-

ing the air from the low pressure to the high pressure air cylinder), hence the differential is 40 pounds less than would be the case with simple compressors having one side of the piston exposed to main reservoir pressure and the other to atmospheric pressure.

Q. Why is the packing ring leakage less in the high pressure steam cylinder?

A. While steam is exerting its force on one side of the high pressure piston, the other side is subjected to such back pressure as obtains from expansion into the low pressure steam cylinder.

Q. Why is the packing ring leakage less in the low pressure steam cylinder?

A. Because while the exhaust side of the piston is open to the atmosphere, the steam pressure on the opposite side of the piston is, as the name of the cylinder implies, comparatively low.

Q. Why cannot the results as stated in the four preceding questions be accomplished with simple compressors?

A. Because with such type of compressors there is a high differential pressure on opposite sides of the pistons. In the steam cylinder the piston has high steam pressure on one side and is open to the atmosphere on the other, while one side of the air piston is working against main reservoir pressure and the other is exposed to atmospheric pressure.

Q. In what way does full stroke of the low pressure air piston increase the capacity of the compressor?

A. As the maximum air pressure in this cylinder never exceeds 40 pounds, the air occupying the clearance space when the piston starts on its return stroke, quickly expands down to atmospheric pressure, permitting the tak-

ing in of free air more promptly and with much less piston movement than is possible when main reservoir pressure in the cylinder must expand to that of the atmosphere.

Q. In what way does this low pressure affect the operation of the valve gear?

A. Against this low pressure the high pressure steam and low pressure air pistons always make their intended and full traverse, thus insuring full movement of the valve gear regardless of the high main reservoir pressure.

Q. Is the stroke of the low pressure steam, and high pressure air pistons affected by high and low main reservoir pressure?

A. Yes, to some extent, though such is of little importance, as it can in no wise interfere with the valve gear or govern the quantity of free air taken into the compressor.

Q. What is the comparative air compressing capacity of the 8½-inch cross-compound and 9½-inch compressors?

A. Under the same operative conditions the cross-compound has a little more than three times the capacity of the 9½-inch compressor.

Q. What is the steam consumption of the 8½-inch cross-compound compressor when supplying the same volume of air as the 9½-inch compressor when working at its maximum capacity?

A. The 8½-inch cross-compound uses about one-third the amount of steam required by the 9½-inch compressor.

Q. How should the air compressor be started?

A. Slowly to allow the condensation to escape from the steam cylinders.

Q. What else should be done at the same time that the steam throttle to the compressor is opened?

A. The lubricator should be started feeding freely at first, until the cylinders have received eight or ten drops of oil; the feed should then be reduced to an amount sufficient to properly lubricate the compressor.

Q. What kind of oil should be used?

A. A good quality of valve oil.

Q. When should the air cylinders be lubricated and what kind of oil should be used?

A. The air cylinders should be lubricated with a small amount of valve oil at occasional intervals.

Q. Why should valve oil be used?

A. Because it has a good body and will stand the temperature of the air cylinders.

Q. Describe the construction and operation of the oil cup.

A. The cup has an air-tight fitting cover and plug cock or key, which is operated by the handle, the key having a recess or cavity in one side. When the handle is in a vertical position, the cavity fills with oil. When the handle is horizontal, the oil flows from the cavity into the oil pipe and finds its way to the air cylinder.

Q. Should oil ever be introduced through the air inlets or strainers?

A. No; such oiling has a tendency to gum up the air valves, passages or strainers, which, in time, may restrict the flow of air sufficiently to reduce the capacity of the compressor.

Q. How tight should the piston rods be packed?

A. Just tight enough to prevent leakage.

Q. What benefit is derived from well-oiled swabs on the piston rods?

A. They keep the piston rods lubricated and assist in oiling the cylinders.

Compressor Disorders and Remedies.

Q. What is the cause if, when starting the compressor, it short strokes or "dances"?

A. Low pressure on the reversing valve allowing it to drop of its own weight; too much lubrication or a bent reversing valve rod.

Q. What could be the trouble if the compressor begins to pound badly after running rapidly for some time?

A. The compressor may be lacking in lubrication. It may also have worked the bolts loose that fasten it to its bracket. If the bracket is weak or loose on the boiler, it would cause the same trouble.

Q. Are there any other causes for the compressor pounding?

A. Yes; too much lift of the air valves; tight packing rings in the piston valve, or loose nuts on the piston rods in the air cylinders.

Q. If the compressor stops in service, from an unknown cause, what might be the trouble?

A. Loose nuts on the piston rod in the low pressure air cylinder; a bent or broken reversing valve rod; the rod disengaged from the reversing valve plate; a loose reversing valve plate; bad packing rings on the main valve, or a dry compressor.

Q. What method should first be tried to start the compressor?

A. Close the compressor throttle for a short time, then open it quickly.

Q. If this fails to start the compressor, what other method might be tried?

A. Tap the steam cylinder head lightly.

Q. What should first be examined if the compressor fails to start?

A. The nuts on the piston rod of the low pressure air cylinder, which can be done by removing the plug in the center of the lower cylinder head. If the trouble is not located, next examine the reversing valve rod, by removing the reversing valve cap.

Q. In the case of loose nuts on the piston rods in the low, or high pressure air cylinders, how should the trouble be remedied?

A. In all cases where possible the compressor should be removed from the locomotive and proper repairs made in the air brake room. Very poor results are liable to be obtained when this work is done without removing the compressor from the locomotive. Using a hammer and chisel to tighten up these nuts is very bad practice, as it does not draw them tight, and often fractures the end of the rod.

Q. What will cause a blow in the cross-compound compressor?

A. Loose rings on the low pressure piston, or on either of the pistons of the piston valve; reversing valve not having a good bearing on its seat; reversing valve rod not fitting snugly in the reversing valve bushing; reversing valve, or piston valve bushing not fitting neatly; or top head gasket leaking between the ports.

Q. If, in handling a long train, the compressor gets hot, what should cause the trouble?

A. Unusually high main reservoir pressure; bad packing rings on the air pistons, the packing in the stuffing boxes being too tight; too little lift of, or stuck air valves; the ports and passages being badly gummed or clogged up, or clogged up air strainers. Any or all of these troubles would produce the effect mentioned. If the compressor and its air pipes are in good condition, it should not run hotter than that caused by the natural heat of compression.

Q. Should the compressor run hot, what should be done?

A. First reduce its speed, then put a small quantity of good oil in the air cylinders, and continue to run the compressor slowly until it cools down.

Q. How can bad packing rings on the low pressure air piston be determined?

A. By noticing the suction at the air inlets. The suction should be good nearly the entire stroke if the packing rings are in proper condition.

Q. If the low pressure air piston packing rings are found in good condition, what should next be done?

A. Ascertain if the air valves have the proper lift ($\frac{3}{32}$ inch).

Q. In fitting new air valves, what rules should be followed?

A. The valve should have a good bearing on the seat, but not too wide. In removing the top of the valve to give the required lift, it should be filed squarely, that it may have a full bearing where it strikes the stop.

Q. What will result from bad packing rings in the high pressure air cylinder?

A. If the leakage is serious, it will have a tendency to slightly slow up the speed of the compressor.

Q. If the packing rings are found to be defective, how should new rings be fitted to the cylinder?

A. The rings should be filed or scraped, to a good bearing all the way around the cylinder. The ends should be filed off so that the ring will fit the smallest part of the cylinder, the ends coming as close together as possible and work free. They should also be a neat fit in the piston grooves.

Q. Is it poor practice to fit rings to a cylinder that is slightly out of round, or not of the same diameter its entire length?

A. Yes.

Q. What should be done if the cylinder is found, from wear, to be smaller in one part than another?

A. It should be re-bored. If this is not done, the rings will permit the air to churn from one end of the cylinder to the other, greatly reducing the efficiency of the compressor, and at the same time contribute largely to excessive heating.

Q. If the air ports or passages are gummed up, how may they be cleaned out?

A. By working a strong, hot solution of lye, or potash, and water through the air cylinders. If the engine is to remain in the round house long enough, the air cylinders and ports may be filled with this solution and allowed to stand until it has cut the gum. If the time will not permit of this, then the solution should be worked through the compressor by running it slowly, to the main reservoir; then worked through the compressor a second time, after which a quantity of fresh water sufficient to thoroughly rinse the compressor should be worked through it. The piston rods should then be re-packed (unless metallic packing is used) and the pipe

joints tightened. Kerosene or coal oil must not be used, as it frequently explodes under pressure, and at best does not do the work thoroughly.

Q. If the compressor makes irregular strokes or "goes lame," where would the trouble be?

A. Probably with the air valves.

Q. What would be the trouble?

A. A valve may be stuck or broken.

Q. If an inlet valve was stuck open or broken, what would result?

A. Air would be drawn into the low pressure cylinder and on the return stroke of the piston, blown back to the atmosphere.

Q. If an inlet valve were stuck closed, what effect would it have?

A. No serious effect. As there are two inlet valves at each end of the low pressure air cylinder the valve still in good condition would permit the cylinder to be supplied with air.

Q. If an intermediate valve was stuck open or broken, what would result?

A. Air would churn back and forth between the high and low pressure air cylinders, and no air would be taken in at the inlet valves at the end of the low pressure cylinder having the stuck or broken intermediate valve.

Q. If an intermediate valve was stuck closed, what effect would it have?

A. Little, if any effect. There being two intermediate valves at each end of the air cylinders, the valve still in good condition would answer the requirements.

Q. What would be the effect if the upper discharge valve was stuck or broken?

A. Main reservoir pressure would always be on top

of the high pressure air piston and cause the compressor to work slowly.

Q. What would be the effect if the lower discharge valve was stuck or broken?

A. Main reservoir pressure would always be under the high pressure air piston, causing the compressor to work slowly.

Q. What could be done out on the road to get the compressor to work regularly?

A. If a valve is stuck, tapping lightly on the outside of the compressor will often dislodge it. If the valve continues to stick, it should be removed, and the foreign matter cleaned off. Though the trouble may be remedied it should be reported upon arrival at the terminal, and the compressor thoroughly cleaned, as gummed-up valves indicate a bad condition of the air cylinders.

Q. If a compressor is in good condition, yet is slow in pumping up air pressure, where might the trouble be?

A. The air strainers may be partially clogged up, which in most cases is the source of this trouble, as it will not permit the low pressure cylinder to be filled with air at each stroke of the piston. Strainers are at times deceiving in external appearance as they may be polished bright and appear to be clean and yet the small perforations may be partially clogged up with dirt.

Q. In the event of the low pressure steam piston or high pressure air piston becoming disabled, can the compressor still supply air?

A. Yes—as under such conditions the compressor becomes single-acting, the same as the 9½-inch compressor.

Q. How would the compressor then operate?

A. Air would be taken into the low pressure air cylin-

der in the usual manner and forced through the high pressure cylinder to the main reservoir.

Q. What main reservoir pressure could be obtained in this way?

A. 40 to 50 pounds.

Main Reservoir.

Q. What is the function of the main reservoir?

A. To receive and store the compressed air delivered by the air pump.

Q. Does the size of the main reservoir affect the operation of the brakes?

A. It does. It should be large enough to contain a sufficient volume of air to promptly charge up the train pipe and auxiliaries when empty.

Q. What is the minimum size reservoir permissible for freight and passenger engines?

A. A capacity of 40,000 cubic inches for freight and 20,000 cubic inches for passenger.

Q. Are there any freight engines equipped with reservoirs of a capacity greater than 40,000 cubic inches?

A. Yes; many of the leading railroads are equipping their heavy freight engines with reservoirs of 50,000 and 60,000 cubic inches capacity, and are getting good results from the increased volume.

Q. Why is a reservoir of large capacity desirable?

A. It permits of carrying a large volume of air with which to promptly charge up an empty train, or to recharge the train pipe and auxiliary reservoirs after an application of the brakes.

Q. Are there any other benefits received from the use of a large main reservoir?

A. Yes; it acts as a cooling or radiating chamber for

the air after it leaves the pump, thereby reducing the temperature of the air and allowing it to pass through the brake valve into the train pipe at a moderate temperature.

Q. What benefit is received by cooling the air before it leaves the main reservoir?

A. It separates the moisture from the compressed air and causes it to settle in the reservoir, whence it can be readily drained out.

Q. What might be the result if this water is not caught in the main reservoir, but goes back through the brake valve into the train pipe?

A. Water passing into the train pipe is very detrimental, as it causes the pipes to rust, and in getting into the triple valves it destroys the lubrication. In the winter time, water in the train pipe is very dangerous, as it is liable to result in a stopped-up train pipe.

Q. Why do freight engines require a larger main reservoir volume than passenger engines?

A. This is owing to the longer trains handled and greater number of auxiliary reservoirs to recharge after an application of the brakes.

Q. Why cannot air be pumped direct into the train pipe, and thus release the brakes?

A. The process is too slow, and on a long train many of the brakes would fail to release; another objection is that the pump would be required to do a great amount of work in a very short time, which would probably cause it to run hot.

Q. How much main reservoir pressure is carried?

A. Ordinarily 90 pounds, although local conditions, and the use of special equipments govern the amount carried.

Q. Is not main reservoir pressure sometimes called excess pressure?

A. Yes; the amount of pressure in the main reservoir above that in the train pipe is called excess pressure.

Q. What is excess pressure used for?

A. To insure a prompt release of brakes and recharging of the auxiliary reservoirs; also, to supply the various air operated devices on the engine without affecting the train pipe pressure.

Q. Where is the starting and ending point of the main reservoir pressure in the brake system?

A. It starts at the discharge valves of the pump and ends at the engineer's brake valve.

Q. What effect does water have in the main reservoir?

A. It occupies space that should be filled with air, and in doing so reduces the capacity of the reservoir.

Q. How often should the main reservoir be drained?

A. At the end of each trip. In suburban or switching service, every 24 hours.

Q. Where does the water come from that is found in the main reservoir?

A. From the atmosphere. Atmospheric air always carries in suspension more or less moisture, which is delivered into the main reservoir with the compressed air, and is condensed into water.

Q. Does leakage at the pump stuffing box affect the amount of water collected in the main reservoir?

A. But very little, as experiments have proven that the amount received through the stuffing box is very small.

WESTINGHOUSE ENGINEER'S BRAKE VALVE.

Q. What is the engineer's brake valve for?

A. For the purpose of enabling the engineer to properly charge, set and release brakes, and control the flow of main reservoir and train pipe pressure.

Q. What style of brake valve is now in general use?

A. The equalizing discharge type.

Q. What advantage is gained by its use?

A. It permits the engineer to make light, uniform reductions throughout long trains, sufficiently fast to cover all leakage grooves, yet not fast enough to obtain quick action; and automatically closes off the discharge gradually, thereby preventing the release of the head brakes of the train.

Q. What are the essential parts of the engineer's brake valve?

A. The rotary valve and the handle which controls it, the equalizing discharge valve, the feed valve attachment, or train pipe governor, and the equalizing reservoir.

Q. What is the purpose of the rotary valve?

A. To open and close the ports in the brake valve.

Q. What is the handle of the brake valve for?

A. To control the movement of the rotary valve.

Q. What is the equalizing discharge valve for?

A. To open and close the train pipe exhaust port according to the pressure above or below it.

Q. What is the equalizing reservoir intended for?

A. To maintain a large volume of air on the upper side of the equalizing discharge valve, in order to compensate for the volume of air in the train pipe, which is on the under side of the equalizing discharge valve.

Q. How many positions are there for the brake valve handle to be placed in?

A. Five; as follows: 1, full release position; 2, running position; 3, lap position; 4, service application; 5, emergency.

Q. Name the different types of Westinghouse engineer's brake valves now in use.

A. The D-8, the F-6, the G-6, the H-6 automatic, and the S-6 independent.

D-8 BRAKE VALVE.

Q. In what respect does the D-8 valve differ from the F-6 or G-6 type of brake valve herein described?

A. The principal difference is in the train pipe controlling device. With the D-8 valve an excess pressure valve is used, while the F-6 and G-6 have a feed valve device to control the train pipe pressure.

Q. Are the positions of the brake valve handle of this valve the same as with the F-6 or G-6 pattern?

A. Yes.

Q. Are the ports in the rotary valve and seat the same in this valve as with the F-6 or G-6?

A. Yes; practically the same, although slight modifications have been made in the general arrangement of the F-6 and G-6 valves to permit of better wearing surfaces.

Q. What is the object of the excess pressure valve?

A. To permit excess pressure to accumulate in the

main reservoir, and to allow air to feed into the train pipe after the excess pressure has been attained.

Q. In what position of the brake valve does the excess pressure valve operate?

A. Running position.

Q. How much excess pressure does this valve maintain?

A. Ordinarily 20 pounds, this being governed by the tension of the spring on the back of the valve.

Q. With the brake valve in running position, will air pass to the train pipe until the excess pressure is obtained?

A. No; in order for air to pass to the train pipe, it must unseat the excess pressure valve; therefore, it cannot pass through unless the air pressure exceeds the tension of the valve spring.

Q. With the D-8 type of brake valve, what volume of air is the pump governor connected to?

A. To the train pipe volume.

Q. If the handle of the D-8 brake valve is placed on lap position while the train pipe pressure is below 70 lbs., what will be the result?

A. The pump will run main reservoir pressure up to boiler pressure.

Q. Why is this?

A. Because the governor cannot shut the pump off unless there is 70 lbs. pressure in the train pipe.

F-6 BRAKE VALVE.

Q. Name the different pipe connections to the F-6 valve.

A. 1, Main reservoir; 2, train pipe; 3, equalizing res-

ervoir; 4, pump governor and red hand of air gauge; 5, black hand of gauge.

Q. How many positions are there in which air is admitted to the train pipe, and what are they?

A. Two. Full release and running position.

Q. How many positions are there in which the train pipe pressure can be discharged? Name them.

A. Two. Service application and emergency position.

Q. What is lap position?

A. Lap position is the position in which all ports in the brake valve are closed.

Q. What is lap position used for?

A. To hold the brakes on after an application, or to prevent main reservoir pressure from passing into the train pipe when the train has parted, or the conductor has applied the brakes with the conductor's valve; also, when coupling to air brake cars.

Q. In what respect does the F-6 brake valve differ from the D-8 type?

A. Principally in the use of the feed valve attachment, in place of the excess pressure valve, although a number of general mechanical improvements have been made in the valve.

Q. What improvement is the feed valve attachment over the excess pressure valve?

A. The feed valve is a device which controls the train pipe pressure, maintaining the standard amount regardless of the excess pressure in the main reservoir, which the excess pressure valve would not do. It is also more sensitive in its action and permits of a convenient method of adjustment; also, is broader in the limits of adjustment.

Q. With the brake valve in running position, is it

necessary to accumulate the excess pressure before air can pass to the train pipe, as it is with the D-8 type?

A. No; this is one of the decided advantages of this valve. With excess pressure valve, considerable trouble was had from the brakes creeping on during the time the pump was raising the excess pressure necessary to open the valve.

Q. How many types of feed valves are there?

A. Two known as the poppet type of feed valve and the slide valve feed valve.

Q. What type of feed valve is used with the F-6 brake valve?

A. The poppet type of valve.

Q. What is the difference between the F-6 brake valve and the G-6 valve?

A. Only in the use of the slide valve feed valve, as described in the following pages.

Q. What is full release position of the brake valve used for?

A. To allow main reservoir pressure to flow quickly and directly into the train pipe, thereby insuring a prompt rise of pressure and the prompt release of the brakes and recharging of the auxiliary reservoirs.

Q. Describe the warning port, and its location.

A. It is a small port about the size of a pin, and passes through the rotary.

Q. What is the function of the warning port?

A. By allowing the air to whistle through it warns the engineer when he is liable to overcharge his train pipe. It should always be kept clean.

Q. To what reservoir is the black hand of the gauge piped?

A. To the equalizing reservoir.

Q. What pressure does the red hand of the gauge indicate?

A. Main reservoir pressure.

G-6 BRAKE VALVE.

Q. Describe the passage of the air through the brake valve when in full release position.

A. Air from the main reservoir flows through the largest ports in the rotary, direct to the train pipe.

Q. What volume of air is at all times in the chamber above the equalizing piston?

A. The equalizing reservoir, or little drum, volume.

Q. What is the object of having the equalizing reservoir always connected to the chamber above the equalizing piston?

A. This is to increase the volume of air of the equalizing piston.

Q. Why is this necessary?

A. Without the equalizing reservoir, the volume of air above the equalizing piston would be so small that it would be difficult to reduce the pressure gradually, which is required during service brake applications.

Q. Is it understood that in all cases, when this chamber is being charged, that the equalizing reservoir is also being charged?

A. Yes; they are at all times in direct communication with each other.

Q. What is the cause of the blow from the direct exhaust opening of the brake valve when in full release position?

A. This is due to the warning port being open, in the rotary valve, and which is always open to the direct ex-

haust when the brake valve handle is in full release position.

Q. What is the object of having this air escape when the handle is in this position?

A. To make a noise and attract the engineer's attention to the fact that the brake valve is in full release position, and that it must be moved to running position to prevent the train pipe from becoming overcharged.

Q. What air pressure is escaping to the atmosphere through the warning port?

A. Main reservoir pressure.

Q. What will happen if the brake valve is left in full release position?

A. The train pipe and main reservoir pressure will equalize, thereby causing the train pipe to become overcharged.

Q. Why would the train pipe be overcharged if it contains the same pressure as the main reservoir?

A. This is owing to the pump governor being connected to the main reservoir volume of air, with this style of brake valve, and which is always adjusted for a pressure above the standard train pipe pressure.

Q. To what position must the brake valve handle be moved to prevent the train pipe from becoming overcharged?

A. Running position.

Q. What are the conditions while the brake valve is in running position?

A. In this position all the air that passes from the main reservoir into the train pipe must pass through the feed valve attachment thus enabling the pump to maintain an excess pressure in the main reservoir.

Q. How many ports in the rotary valve seat are open in running position?

A. Two; one leading to the feed valve attachment, and the other to the chamber above the equalizing piston.

Q. With this attachment what pressure is allowed in the train pipe, and what pressure in main reservoir?

A. Seventy pounds in train pipe, and 90 pounds in main reservoir, unless the high speed apparatus is in use.

Q. Why will the train pipe not become overcharged with the brake valve in running position?

A. Because, in this position all air which enters the train pipe must pass through the feed valve attachment which controls the train pipe pressure, as this valve automatically closes off when the desired pressure is obtained.

Q. What air pressure is always present above the rotary valve?

A. Main reservoir pressure.

Q. When is the running position of the brake valve used?

A. While running over the road when the brakes are not being operated, in order that the feed valve may control the train pipe pressure.

Q. What is lap position used for?

A. To prevent the main reservoir pressure from entering the train pipe, or the train pipe pressure from passing through the valve to the atmosphere.

Q. Are there any ports open to the brake valve on lap?

A. No; all communication through the brake valve is cut off.

Q. After applying the brakes how should the handle be brought to lap?

A. It should be brought to lap carefully, and held there until it is desired to further reduce train pipe pressure, or release the brakes as the case may be.

Q. When releasing the brakes how must the brake valve be handled?

A. The handle should be placed on full release for a few seconds, according to the length of the train and the amount of excess pressure carried, before it is allowed to rest on running position.

Q. Describe the conditions when the brake valve is in service application position.

A. In this position the air on top of the equalizing discharge valve is allowed to escape so gradually that a sudden reduction of train pipe pressure is prevented.

Q. In making a service brake application does it require that the brake valve handle be left in application position any longer to make a 10 pound reduction on 40 cars than it would with 10?

A. No; for in service position the volume of air which is reduced always remains constant, that being the air pressure in the chamber and the equalizing reservoir.

Q. If the brake valve handle is left in service position until 10 pounds is drawn from the top of discharge valve, and then placed on lap, what is the result?

A. The valve will not seat until a fraction over 10 pounds has escaped from the train pipe, when the pressure on top will then be the greatest, and force the discharge valve back to its seat, thereby closing the train pipe exhaust.

Q. When should emergency position be used?

A. Only in case of danger.

Q. What conditions prevail in the brake valve during an emergency application?

A. In this position the rotary connects the main train pipe supply port with the main exhaust port thus allowing the air to escape from the train pipe direct to the atmosphere regardless of the equalizing discharge valve.

Q. What effect does this sudden reduction of train pipe pressure have on the triple valves?

A. It allows them to be forced to their full stroke, thus causing quick action or emergency application.

Q. With the brake valve handle in emergency position, does any air pressure escape from the train pipe at the train pipe exhaust fitting?

A. No; in emergency position of the brake valve the equalizing piston does not move; therefore no air can escape from the train pipe exhaust.

Q. What precautions must be observed in applying brakes with the quick action triple?

A. The reduction in train pipe pressure should be made gradually in order to prevent an emergency application.

Q. Sometimes a very noticeable flash occurs at the train pipe service exhaust when releasing brakes, as though the equalization piston had raised. It is a noticeable fact that this never occurs with a long train, but only with the light engine or a few cars. What causes it?

A. When the valve handle is placed in full release position, the supply to the train pipe is much greater than that to the equalizing reservoir, thus charging the chamber under the equalizing piston faster than the chamber above it. This causes the piston to rise until the pressures equalize.

THE TRIPLE VALVE.

Q. What relation does the triple valve bear to the automatic air brake?

A. It is a very important and essential part of the system.

Q. In general, what is the function of the triple valve?

A. It controls the passage of the compressed air from the auxiliary reservoir into the brake cylinder during an application; and it also releases the pressure from the brake cylinder at the will of the engineer. After release, the triple valve again assumes the position in which the air can pass through it to recharge the auxiliary reservoir.

PLAIN TRIPLE.

Q. Name the operative parts of the plain triple valve.

A. This valve consists of a piston, slide valve, graduating valve, graduating stem, graduating stem spring and slide valve spring.

Q. How many positions are there to a plain triple, and what are they?

A. Four; release, service, lap and emergency positions.

RELEASE POSITION.

Q. What is the normal position of the triple valve?

A. Release position.

Q. What is the purpose of release position of the valve?

A. To allow the auxiliary reservoir to be charged, and to exhaust the air from the cylinder to permit the brakes to release.

Q. Explain how the air passes through the triple valve in order to charge the auxiliary reservoir?

A. Air enters from the train pipe connection, passes through a port into graduating stem case, thence through another port to the piston chamber. The piston being in release position, and the feed port in the bushing being open, the air is free to pass through this port, also another port on the piston shoulder to the slide valve chamber, thence through pipe connection to the auxiliary reservoir.

Q. When the auxiliary reservoir is fully charged, how do the pressures stand on the opposite sides of the triple valve piston?

A. Equal; in other words equalized.

SERVICE APPLICATION POSITION.

Q. With the auxiliary reservoir charged and the valve in release position, what must be done to cause the piston to move to service application position?

A. The train pipe pressure must be reduced below that in the auxiliary reservoir.

Q. How much of a train pipe reduction should be made to cause this valve to move to application position?

A. Not less than 5 pounds.

Q. Explain what takes place as the triple valve piston moves to service position?

A. As the piston starts down, the first slight movement causes it to close the feed port and unseat the graduating valve. A shoulder on the end of the triple piston stem, then becomes engaged with the end of the

slide valve, causing it to be moved to service position, in which the exhaust cavity is no longer in communication with the brake cylinder port, but a port in the slide valve is now in register with a port in the seat, which leads to the brake cylinder.

Q. As the piston moves toward service position, what resists its movement and prevents it from moving the full length of its cylinder?

A. The graduating stem, with which the knob on the plain side of the triple valve piston becomes engaged, as the piston reaches service position.

Q. What is the duty of the graduating stem and spring?

A. To act as a bumping post for the triple valve piston, which will prevent it from going to the emergency position during service application.

Q. Explain the flow of air through the triple valve in service application position.

A. A port on the slide valve is in register with a port in the seat; therefore, as the graduating valve is unseated, auxiliary reservoir pressure, which always surrounds the slide valve, is free to pass through ports in the slide valve to the graduating valve seat and thence through other ports to the brake cylinder.

Q. If 5 pounds of pressure is reduced from the train pipe, how much will leave the auxiliary reservoir?

A. Just a little more than 5 pounds.

Q. Why will just a little more than 5 pounds leave the auxiliary?

A. Owing to the reservoir pressure expanding into the brake cylinder as long as the graduating valve is open, which eventually will cause the auxiliary pressure to become a little lower than that which remains in the

train pipe. The train pipe pressure then being the greater of the two causes the triple valve piston to move forward sufficiently to seat the graduating valve and prevent any further flow of air from the auxiliary reservoir to the brake cylinder.

LAP POSITION.

Q. What is lap position of the triple valve?

A. The position in which the graduating valve is closed.

Q. Does the slide valve move after the first reduction has been made?

A. No; not until the brakes are fully applied or released.

Q. What takes place when the second reduction is made in the train pipe?

A. The triple piston again moves until it reaches the graduating stem, unseating the graduating valve, and allowing auxiliary pressure to pass to the brake cylinder in equal amount to that reduced in the train pipe, when the piston will move forward, and again seat the graduating valve.

Q. Does the triple valve piston move with every reduction that is made in the train pipe?

A. Yes; every considerable reduction, and by so doing it unseats the graduating valve.

Q. How much of a reduction will be required to fully apply the brake in service?

A. About 20 pounds if the piston travel is adjusted properly.

Q. How much pressure will that develop in the brake cylinder?

A. About 50 pounds.

Q. How much pressure will remain in the auxiliary reservoir in this case?

A. About 50 pounds, as the auxiliary reservoir and brake cylinder pressure always stand equal when brakes are fully applied.

Q. How will the triple valve operate if the train pipe pressure is reduced more than the amount required to equalize the auxiliary and brake cylinder pressures?

A. The triple valve piston will drive the graduating stem down, compressing the graduating stem spring, and traveling the full length of its cylinder, until it rests upon the leather gasket.

Q. With the triple valve in application position, what must be done to cause it to move to release position?

A. The train pipe pressure must be made greater than the auxiliary reservoir pressure.

Q. How can this be accomplished?

A. Either by increasing the train pipe pressure until it is greater than the auxiliary reservoir pressure, or the auxiliary reservoir pressure may be reduced below that which is in the train pipe.

EMERGENCY APPLICATION POSITION.

Q. What is the fourth position of the triple valve?

A. Emergency position.

Q. What is the object of the emergency position of the triple valve?

A. To allow the air to pass from the auxiliary reservoir to the brake cylinder quickly.

Q. What must be done to cause the triple valve piston to move to the emergency position?

A. A sudden reduction of air pressure must be made in the train pipe.

Q. Explain the operation of the triple valve as it moves to the emergency position.

A. The quick reduction made in the train pipe causes the auxiliary reservoir pressure to drive the piston down quickly, the knob on the triple valve piston to strike the graduating stem with considerable force, driving it down and compressing the graduating stem spring. This movement of the piston has caused the slide valve to be moved downward until it entirely uncovers a port in the slide valve seat, thereby permitting auxiliary reservoir pressure, which is always present in chamber e, to pass directly to the brake cylinder. This brings about a quick equalization of the auxiliary reservoir and brake cylinder pressures.

Q. Does the emergency action of this triple valve give any greater braking power in the brake cylinder than would be obtained if a full service application were made?

A. No; the only benefit received from the plain triple valve in emergency is that a quicker application of the brake will be had.

Q. Are there any more than one type of plain triple valve?

A. Yes; there are several different types in service, but the two standard types now furnished are the H-24 and F-46.

Q. What is the principal difference in these two types of valves?

A. Only in the sizes of the ports and the various operative parts.

Q. Why must different size ports be used in these different valves?

A. Because they are used with different size cylinders and reservoirs.

Q. What are the dimensions of the graduating spring used in the plain triple valve?

A. Phosphor bronze spring wire, number 14 B. W. G., 83-1000 inch in diameter, 12 coils, 2½ inches, free height, 25-64 inches inside diameter.

WESTINGHOUSE QUICK ACTION TRIPLE VALVE.

Q. How many, and what are the positions of the quick action triple valve?

A. Five; release, charging, service, lap and emergency.

Q. In what respect do the passenger and freight car triple valves differ?

A. With passenger car triple valves, heavier graduating stem springs are used and a different style of emergency valve piston. There is also a difference in the size of the slide valve and various ports throughout the valve.

Q. Name the different parts of the quick action triple valve.

A. Slide valve, triple piston, piston packing ring, slide valve spring, graduating valve, emergency piston, emergency valve, check valve spring, check valve, graduating stem, and graduating stem spring.

Q. How many complete sets of operative parts has the quick action triple valve?

A. Two; the service parts and the emergency parts.

Q. Name the parts of the quick action triple valve that operate during service application?

A. The triple valve piston, the slide valve and graduating valve.

Q. How can the freight car triple valves be distinguished from the passenger car triple valve other than by the lettering on the triple valve body?

A. By the exhaust outlets. All freight car triples have two exhaust outlets, while the passenger car valves have but one.

Q. What are the dimensions of the graduating stem springs used in the passenger car triple valves?

A With the F-27 and F-29 type of valves, the springs are made of wire 8-100 of an inch in diameter, 13¼ coils, 2⅝ inches free height, and 29-64 inches inside diameter, while with the freight triple valves F-36 and H-49, wire of 49-1000 of an inch in diameter is used, 16 coils and 2¾ inches free height, the inside diameter being 29-64 inches.

Q. Why are heavier graduating springs used on passenger cars than on freight cars?

A. Owing to the shorter train pipe of a passenger train the triple valve pistons move more quickly and require more resistance to stop them in service position.

RELEASE AND CHARGING POSITIONS.

Q. What can be said of these positions?

A. They are really one, and the same.

Q. Explain why.

A. While the air is being released from the brake cylinder by way of the ports in the slide valve seat, the auxiliary is being charged by way of the feed grooves.

Q. What is the time required to charge an auxiliary reservoir from zero to 70 pounds?

A. With triple valve in proper condition and 70 pounds of pressure maintained in the train pipe it will require approximately 1¼ minutes.

Q. What controls the flow of air from the train pipe to the auxiliary reservoir?

A. The feed ports in the triple piston bushing and in the piston seat.

Q. What is the object in making the feed groove so small?

A. In order to permit of a uniform charging of all auxiliary reservoirs in a long train, also to prevent auxiliary reservoir pressure from passing back into the train pipe during service brake application.

Q. As was described, the F-29 triple valves are used in connection with larger reservoirs, the F-27 with smaller. Is it possible to charge both reservoirs in the same length of time?

A. Yes; because the feed ports are made in proportion to the size of the reservoir with which the triple valve is to be used.

Q. What must be done to cause this valve to move to application position?

A. The train pipe pressure must be reduced below that which is in the auxiliary reservoir.

SERVICE APPLICATION POSITION.

Q. Explain the action of this triple valve after a light service application is made.

A. The train pipe pressure being reduced below that in the auxiliary reservoir and chamber m, the greater pressure on the auxiliary side of the piston causes it to move to the left. By so doing, the feed port is closed, cutting off connection between the auxiliary reservoir and train pipe, the graduating valve unseats and the slide valve moves until a port in the slide valve is

brought in register with a port in the slide valve seat, which leads to the brake cylinder.

Q. What causes the triple valve piston to stop when it reaches this position in which the ports in the slide valve and the seat are in register?

A. The resistance of the graduating stem and spring with which the knob on the triple valve piston becomes engaged when it reaches this position.

Q. Explain the flow of air through the triple valve in service application position.

A. With the triple valve in service application position, the auxiliary reservoir pressure, which is always present around the slide valve, is free to pass through ports in the side of the slide valve by the graduating valve which is unseated, thence through ports in the slide valve, and the seat, to the brake cylinder.

Q. How much air will pass from the auxiliary reservoir during this service application?

A. Just a trifle more than the amount which was reduced in the train pipe.

Q. With the graduating valve open as shown, why will not the auxiliary pressure continue to flow to the brake cylinder?

A. Because, as the pressure in the auxiliary reservoir expands into the brake cylinder, and becomes a trifle lower than that which remains in the train pipe, train pipe pressure causes the triple piston to move forward sufficiently to seat the graduating valve, thereby stopping any further flow of air from the reservoir to the brake cylinder.

LAP POSITION.

Q. With the triple valve in lap position, what occurs if another light reduction in train pipe pressure is made?

A. The triple piston will again move back until it engages the graduating stem, thus unseating the graduating valve, which will allow auxiliary reservoir pressure to again pass through to the brake cylinder in amount equal to that reduced in the train pipe, when the piston again seats the graduating valve.

Q. Does the slide valve move with every reduction in train pipe pressure?

A. No; the slide valve of the triple valve moves only once with a brake application. The piston and graduating valve, however, move with every reduction.

Q. What is meant by the term "application of an air brake?"

A. From the time the brake is first applied until fully released. This might be made with one or more train pipe reductions.

Q. If, during a service brake application, the pressure in the train pipe is reduced below that at which the auxiliary reservoir and brake cylinders will equalize, how will the triple valve operate?

A. The piston will move to the left until it strikes the body gasket, and will remain in this position as long as the auxiliary reservoir pressure is above that in the train pipe.

Q. Do we get any further braking power by this movement?

A. No; braking power cannot be increased after equalization has once taken place between the auxiliary reservoir and brake cylinder, no matter how much more air may be reduced in the train pipe.

Q. With the triple valve in application position, what must be done to cause the same to move to release position?

A. The pressure in the train pipe must be made greater than that which is in the auxiliary reservoir.

Q. How can this be accomplished?

A. Either by the engineer charging up the train pipe until the pressure exceeds the reservoir pressure, or by the train men reducing the auxiliary reservoir pressure below that in the train pipe.

Q. What two things does the triple valve do when it moves to release position?

A. It opens the feed port in order to again allow the auxiliary reservoir to recharge, and opens the exhaust port from the brake cylinder to the atmosphere, permitting the brakes to release.

Q. Explain how the air escapes from the brake cylinder to the atmosphere when the triple valve is in release position.

A. A cavity in the slide valve connects cylinder port and exhaust port together, thereby permitting the air to leave the brake cylinder and escape.

Q. After having made a brake application and reduced the auxiliary reservoir pressure to 50 pounds, what will be the time required to recharge the auxiliary reservoir again to 70 pounds pressure?

A. Not less than 35 seconds if the train pipe pressure is fully restored to 70 pounds.

EMERGENCY APPLICATION POSITION.

Q. With the auxiliary reservoir fully charged, what must be done to cause the triple valve to operate in emergency?

A. A quick reduction of pressure must be made in the train pipe.

Q. Explain the operation of the triple valve in emergency.

A. A sudden reduction of train pipe pressure causes the triple piston to move out so quickly that the graduating stem spring cannot withstand the impact of the knob on the triple valve piston, but yields, so that the piston moves to the limit of its travel.

In this position, the removed corner of the slide valve uncovers a port in the slide valve seat, which admits air from the slide valve chamber to the chamber above the emergency piston, which results in forcing the emergency piston down and unseats the emergency valve. With the emergency valve unseated, air pressure in the chamber, above the check valve, escapes to the brake cylinder which then permits train pipe pressure to raise the check valve and also pass to the brake cylinder until the train pipe and brake cylinder pressures equalize, when the check valve reseats. A port of the slide valve and another port in the seat are in direct communication, which will, therefore, allow auxiliary reservoir pressure to pass to the brake cylinder until the pressures become equalized.

Q. At what pressure will the auxiliary reservoirs and brake cylinders equalize with an emergency application and proper piston travel?

A. About 60 pounds.

Q. As it is understood that train pipe and auxiliary reservoir pressures both pass to the brake cylinder during an emergency application, what volume of air reaches the cylinder?

A. A small amount of auxiliary reservoir pressure is admitted to the brake cylinder as the service port is passing over the cylinder port, but the air pressure from

the train pipe is the first to reach the cylinder in any considerable volume. It will be noted that the port in the slide valve is restricted in size. This is for the purpose of permitting the train pipe pressure to reach the cylinder before any great auxiliary reservoir volume can pass to the brake cylinder.

Q. What advantage is gained by having the triple valve piston make a joint with the graduating cap gasket when in emergency position?

A. This is to prevent auxiliary reservoir pressure from leaking into the train pipe past the triple valve piston packing ring.

Q. In releasing the brake after an emergency application, is a higher train pipe pressure required than would be necessary if the brakes were fully applied in service?

A. Yes; to release brakes after an emergency application, the train pipe pressure must be raised above 60 pounds; whereas, with a full service application, the brakes can be released with a little over 50 pounds train pipe pressure.

THE PRESSURE RETAINING VALVE.

Q. What is the purpose of the pressure retaining valve?

A. Its purpose primarily is to retain a limited, predetermined amount of pressure in the brake cylinders of the train, in heavy grade service, thereby holding the speed of the train in check during the time the auxiliary reservoirs are being charged.

Q. Does it not also perform other useful duties?

A. Yes; it permits of a much safer handling of the train, the maintenance of a more uniform rate of speed

down heavy grades, and causes a great saving in air pressure, which means less labor for the air pump. It also gives an increased cylinder pressure and higher braking power, with a lower consumption of air pressure. Likewise, it permits of a greater reserve in stopping power for emergencies.

Q. Briefly describe the construction of the pressure retaining valve?

A. It consists of a weighted valve enclosed in a casing, and seated in a passage way. This valve is screwed on the opposite end of a pipe coupled to the exhaust port of the triple valve.

Q. Describe its operation when the handle is turned down, pointing to the ground.

A. When the handle is pointing downward, pressure escapes from the brake cylinder, through the triple valve, passes through the retaining valve pipe to the retaining valve, where it escapes freely to the atmosphere. In this position the valve is non-operative and performs no useful work.

Q. When the handle of the retaining valve is turned horizontal, how does it operate?

A. When the handle is turned up, pointing in a horizontal line, the direct outlet from the retaining valve pipe is closed, and a passage way is made through the cock to the under side of the weighted valve on its seat. All pressure over 15 pounds will hold the valve lifted from its seat and escape through a small port from the cage enclosing the weighted valve. The weighted valve is so proportioned that it will seat when only 15 pounds pressure is exerted upon it. Thus the last 15 pounds are retained in the brake cylinder, which is sufficient to steady the train while the brakes are being recharged.

Q. The retaining valve then merely performs the useful service of holding 15 pounds in the brake cylinder?

A. Not only this, but the passage way out of the casing to the atmosphere is so small that considerable time is consumed in discharging the entire brake cylinder through the small port. This renders the release of the brake much slower, and exerts a retarding effect which also gives more time for the auxiliary reservoir to recharge.

Q. Is this small escape port in the cap, or cage, the same size for all retaining valves?

A. No; it is 1-16 inch for retaining valves used on 6, 8 and 10-inch cylinders, and ⅛ inch for 12, 14 and 16-inch cylinders. These port sizes give a restriction, which requires about 30 to 60 seconds for the full cylinder pressure to escape down to the amount limited by the weighted valve.

Q. Describe the construction of the three position retaining valve.

A. It has two separate weighted valves, one of the ordinary form, the other being of an inverted cup shape, resting upon the top of the ordinary weight.

Q. How does this valve operate?

A. When the handle points downward, the valve is inoperative, and brake cylinder pressure escapes freely to the atmosphere through the large release port of the valve.

Q. When the handle is turned half way up, at an angle of 45 degrees, how does the valve operate?

A. The large release port is cut off, and both weights now resist the escape of brake cylinder pressure through the retaining valve, and as their combined weights have

a resistance equal to 50 pounds of pressure, that amount is retained in the brake cylinder.

Q. Why is it necessary to retain such a high pressure?

A. Experience has proved it desirable, on high capacity steel cars, to hold this amount continuously in the brake cylinders in heavy grade service, on account of the low percentage of braking power on these cars when loaded.

Q. When the handle is turned up to horizontal position, how does the valve operate?

A. The heel, or projection, on the handle strikes a pin which, in being forced upward against the inverted cup weight, lifts that weight from the top of the other weight, thus permitting the latter to perform its usual function of retaining 25 pounds in the brake cylinder.

RETAINING VALVE DISORDERS.

Q. Is the retaining valve of any decided advantage in driver brake operation?

A. It would be were it not for the fact that driver brake packings generally leak badly, and the numerous connections in the brake cylinder pipe frequently become loose and cause leakage. With these avenues of escape for pressure, the retaining valve is unable to perform its intended function. The driver brake retaining valve has almost entirely given way to the combined automatic and straight air brake which overcomes this leakage difficulty.

Q. If there is a steady leakage of pressure at the retaining valve exhaust while brakes are released, should the trouble be looked for in the retaining valve?

A. No; the trouble will generally be found in the rubber seated emergency valve in the triple.

Q. If the retaining valve handle has been turned up in operative position, brakes then released, and after a few moments the handle is turned down and no air escapes, is the fault in the retaining valve?

A. No; it is either in a leaky joint or connection in the pipe, or in the brake cylinder packing.

Q. Should air refuse to pass through the retaining valve with handle turned down, and brake remain set, where should the trouble be looked for?

A. At the exhaust port. It may be stopped up by accumulation of dirt, pipe scale, or cuttings. Sometimes insects build and stop up the port.

THE K TRIPLE VALVE.

Q. In what respect does the type K triple valve differ from the standard quick action triple?

A. It has three additional features known as quick service, uniform release and uniform recharge.

Q. Why are these added features necessary?

A. To meet modern conditions of freight service.

Q. Why is the older type (F-36 or H-49) triple valve not satisfactory on trains consisting of more than 50 cars?

A. Being originally designed for trains of not more than 50 cars it is unable to handle the increased volume of air required on longer trains.

Q. How are the F-36 and H-49 triple valves at present designated?

A. The H-1, and H-2 triples.

Q. With the same discharge opening at the brake valve why do the type "K" triple valves apply more promptly and uniformly than the old standard types?

A. The Quick Service feature of the "K" valve makes

a supplementary brake pipe reduction at each triple valve.

Q. How is this supplementary or local brake pipe reduction obtained?

A. When a brake pipe reduction is made at the brake valve, the first triple valve moves to quick service position, in which position a port is open from the brake pipe to the brake cylinder, which permits the brake pipe air to flow to the brake cylinder, making a local brake pipe reduction which affects the next valve, causing a rapid serial application throughout the train.

Q. Does air flow from the auxiliary reservoir to the cylinder at the same time it flows from the brake pipe to the cylinder?

A. Yes. The service port from the auxiliary reservoir to the cylinder is open when the quick service port is open.

Q. What controls the opening of the quick service port?

A. The triple valve slide valve, and graduating valve.

Q. Is the quick service feature operative with short trains?

A. No. This feature automatically goes out of service when the brake pipe pressure is being reduced at the proper rate.

Q. What increase of brake cylinder pressure is obtained by use of the quick service feature?

A. About one pound higher equalization under normal conditions of piston travel and cylinder leakage.

Q. What other advantages are obtained from the quick service feature in addition to the higher cylinder pressure?

A. The application of all brakes with light brake pipe

reductions; time of application is reduced about one-half; also a uniform application is obtained throughout the train.

Q. Is less air consumed in handling a train equipped with quick service triple valves than would be the case with valves not having this feature?

A. Yes. A considerable portion of the brake pipe air which is ordinarily discharged to the atmosphere enters the brake cylinders, therefore not requiring as heavy brake pipe reductions to obtain the same cylinder pressure as would be the case where auxiliary reservoir air alone enters the cylinder, but chiefly because, for a given train and speed, the same stop can be made with a much lighter brake pipe reduction with the "K" valves, due to uniform application throughout the train.

Q. Is the advantage of the quick service feature obtained where quick service triples are mixed in a train with triple valves not having this feature?

A. Yes. The advantages obtained are in proportion to the number of quick service triple valves in the train.

Q. Will the discharge of air from the brake valve exhaust with a given reduction be as long with a train of quick service triple valves as would be the case if the train was equipped with triple valves not having the quick service feature?

A. No. The time of discharge from the brake valve would be reduced about one-half.

Q. How many service positions has the type "K" triple valve?

A. Two: Quick Service and Full Service positions.

Q. From an external view what distinguishes the type "K" valve from other types?

A. A lug or fin cast on the top of the valve body.

Q. What is the object of the Uniform Release feature of the "K" triple valve?

A. To provide a uniform release of brake cylinder pressure through the entire train and prevent the severe shocks, and possible break-in-twos often experienced with a long train equipped with triple valves not having this feature.

Q. When the brake valve is placed in release position in order to release the train brakes, on what portion of the train do the triple valves move to release position first?

A. On the head end.

Q. Why do the valves on the head end move to release position before those on the rear end?

A. Owing to the prompt rise in brake pipe pressure on the head end when the brake valve is placed in release position and the slow rise of pressure on the rear end.

Q. What prevents the pressure from raising promptly on the rear of a long train if a high pressure exists in the main reservoir at the time the brake valve is moved to release position?

A. The frictional resistance to the flow of air through the long brake pipe combined with its many bends makes it impossible to raise the pressure promptly on the rear end.

Q. How many release positions has the type "K" triple valve?

A. Two: Normal and Retarded Release.

Q. How do these two positions differ, insofar as the release of brake cylinder pressure is concerned?

A. In normal release position, the exhaust opening is large, which permits of a prompt fall of brake cylinder pressure; in retarded release position, the exhaust open-

ing is small, which restricts the fall of brake cylinder pressure.

Q. What controls the movement of the valve to normal or retarded release position?

A. The rate of rise of brake pipe pressure as compared with that in the auxiliary reservoir. If this is slow the valve moves to normal release position; if quick, the valve moves to retarded release position.

Q. Explain briefly the uniform release feature of the "K" triple valve.

A. Connected to the auxiliary end of the triple valve body is a casing in which is a stem and spring so located as to stop the triple piston and slide valve in normal release position when the brake pipe pressure is raised gradually. However, if the rise in brake pipe pressure is sufficiently prompt to increase it materially above the auxiliary reservoir pressure the differential pressure thus set up will be sufficient to move the triple piston and slide valve to retarded release position, compressing the retarding spring.

Q. What difference in pressure between the brake pipe and auxiliary reservoir is required to compress the retarding spring, and cause the valve to move to retarded release position?

A. About three pounds.

Q. In releasing the brakes on a fifty-car train or longer, with the brake valve held in release position, about how far back in the train will the valves move to retarded release position?

A. About thirty cars immediately back of the engine.

Q. Why will the valves beyond this point not go to retarded release position?

A. Because with a long train it is impossible to raise

the brake pipe pressure three pounds above the auxiliary reservoir pressure for more than thirty cars back in the train.

Q. If the head triple valves move to release first, why are not the head brakes released first?

A. The restricted exhaust opening of the "K" valve in retarded release position causes the brake cylinder pressure to fall sufficiently slow as to permit the rear triples of a long train to move to normal release position and discharge the brake cylinder pressure to five pounds on the rear in approximately the same time the cylinder pressure on the head end is reduced to five pounds.

What other feature does the "K" triple valve possess that is valuable at the time brakes are being released?

A. The uniform recharge feature.

Q. What is meant by uniform recharge?

A. The recharging of the auxiliary reservoirs on the head, and rear of the train at approximately the same rate.

Q. Why is this necessary?

A. To prevent the reapplication of the head brakes, when the brake valve is moved from release to running position, as would occur, if the head auxiliary reservoirs were overcharged.

Q. If the feed grooves of triple valves in the trains are the same size, why will the head auxiliary reservoirs charge faster than the rear ones?

A. When the brake valve is placed in release position, the brake pipe pressure on the head end is raised promptly above that in the auxiliary reservoirs, whereas the brake pipe pressure on the rear is raised slowly, this difference in brake pressure resulting in the head reservoirs charging more promptly than those on the rear.

Q. How does the "K" triple valve permit a uniform recharge when the brake pipe pressure is higher on the head end than on the rear end?

A. The charging ports and grooves are so arranged that with the triple valves in retarded release position (as would be the case where the brake pipe pressure is high), a small opening is had from the brake pipe to the auxiliary reservoirs; when the valves are in normal release position, a large opening is had from the brake pipe to the reservoirs. This difference in sizes of charging openings compensates for the difference in brake pipe pressure at the two ends of the train.

Q. Is any other benefit obtained by retarding the recharge of the head auxiliary reservoirs?

A. Yes. It permits a greater volume of air to flow to the rear, insuring a higher pressure and a more prompt release of the rear brakes.

Q. Does the retarded recharge feature interfere with the proper handling of trains on grades?

A. No. The retarded release feature combined with the quick service feature more than compensates for the retarding of recharge on the head end, and the uniform recharge more evenly distributes the brake work on the train.

Q. With all cars equipped with "K" triple valves, can the brakes on long trains be released at low speed without danger of a break in two.

A. Yes. The retarded release feature operating on about thirty of the head brakes will be sufficient to keep the slack from running out.

Q. If a number of "K" triple valves are located in the rear of a long train of old type of triple valves will

the slack run out on the head end due to the retarded release feature of the "K" triple valves?

A. No. "K" triple valves on the rear of long trains do not go to retarded release position.

Q. With "K" valves scattered through a train equipped with old type of triple valves, would the higher cylinder pressure obtained with the "K" triple valves be sufficient to cause trouble?

A. No. The ordinary variation in piston travel found on different cars in the train results in a greater difference in cylinder pressure than would be had between the type "K" triple valves and old type triple valves.

Q. Will "K" triple valves work in perfect harmony with old style triple valves?

A. Yes. They not only work in harmony, but greatly improve the action of the older type.

Q. How should a brake be bled off by hand if there is air pressure in the brake pipe?

A. The release valve on the auxiliary reservoirs should be held open only until the discharge of air is heard at the retaining valve.

Q. What will be the effect if the release valve is held open after air commences to discharge from the retaining valve?

A. The triple valve will move to retarded release position and be much slower in releasing the brake.

Q. How should the brake be released by hand if there is no air in the brake pipe?

A. The release valve should be held open until all the air is exhausted from the brake cylinder.

Q. Is there any difference in the emergency parts of a "K" triple valve as compared to the old type quick action triple valves?

A. No. All parts are the same and interchangeable.

Q. How many sizes of "K" triple valves are there?

A. Two: The K-1 and K-2.

Q. What sizes of brake cylinders are these used with?

A. The K-1 for 8-inch cylinder, and the K-2 for 10-inch cylinders.

Q. Can the features of the type "K" valve be incorporated in the H-1 and H-2 valves?

A. Yes.

Q. How may the K-1 triple valve be distinguished from the K-2?

A. The K-1 has two holes in the reservoir flange, while the K-2 has three.

FULL RELEASE AND CHARGING POSITION.

Q. Explain the flow of air through the triple valve, in full release and charging position.

A. Air entering from the brake pipe flows through the cylinder cap and port to a chamber on the face of the triple piston; thence through the feed port to the slide valve chamber (which is always in free communication with the auxiliary reservoir). At the same time brake pipe air which has raised the check valve and filled that chamber, flows through the port in the body and valve seat and a port in the slide valve to the slide valve chamber until the auxiliary reservoir is charged equal to the brake pipe pressure. Brake cylinder air is now free to pass to the atmosphere.

Q. What is the object of having two passages through which the auxiliary reservoir is charged?

A. As the K-2 triple valve is used with an auxiliary reservoir of suitable size for a 10-inch cylinder, it is so large that to charge it in proper time through a single

feed port "i" would require such port to be of considerable size, which would permit of an appreciable amount of auxiliary air feeding back into the brake pipe when a brake pipe reduction was made. For this reason the feed port "k" is made the same size in the K-1 and K-2 triple valves.

Q. With the feed port the same size in both the K-1 and K-2 valves, why will the reservoirs charge uniformly when the valves are in retarded release position?

A. When the valves are in retarded release position the auxiliary side of the piston comes in contact with the end of the slide valve bushing, making an airtight seal, except at one point where a small feed groove is cut in the piston to allow air to pass by the end of the slide valve bushing into the chamber and auxiliary reservoir. The size of this groove controls the charging of the auxiliary reservoirs when the valves are in retarded release position. The feed groove in the piston of the K-2 valve is larger than in the K-1; therefore both sizes of auxiliary reservoirs are charged in approximately the same time.

Q. Is there any other difference between the K-1 and K-2 valves?

A. No; in all other respects both valves are the same (except in size of parts and ports), therefore it will only be necessary in the following to consider the K-2 triple valve.

Q. With the triple valve in full release position, and the brake pipe and auxiliary reservoir pressure equal what must be done to cause the valve to move to application position and apply the brake?

A. The air pressure on the brake pipe side of the triple

piston must be reduced below that on the auxiliary reservoir side.

Q. About how much lower must the brake pipe pressure be than the auxiliary reservoir pressure to cause the triple valve to move to application position?

A. About two pounds, or just enough to overcome the friction of the slide valve on its seat, and the piston packing ring in its cylinder.

QUICK SERVICE POSITION.

Q. Explain the action of the triple valve as it moves from release position to quick service position.

A. As the brake pipe pressure is reduced below auxiliary reservoir pressure the triple piston moves to the right until the spider on the end of the piston stem engages the slide valve, this movement permitting the piston to close the feed groove and move the graduating valve until it opens the service port in the top of the slide valve, and its cavity connects the two ports in the top of the slide valve; the piston continues its movement carrying the slide valve until it is arrested by the graduating stem, which is held in place by the compression of graduating spring. Two ports in the seat are in register with the ports in the slide valve. In this position of the valve auxiliary reservoir air flows through a port in the slide valve and the port in the seat to the brake cylinder.

Q. In quick service position service port "Z" in the slide valve is not in full register with brake cylinder port "r"; explain the reason for this.

A. The opening as shown is sufficient to permit the air in the auxiliary reservoir to reduce by flowing to the brake cylinder as fast as the pressure is reducing in the brake pipe when the train is of considerable length.

However, if the brake pipe is reduced more rapidly than that of the auxiliary reservoir, as may be the case on short trains or trains having heavy brake pipe leakage, the auxiliary reservoir pressure would become sufficiently above that in the brake pipe as to cause the triple piston to slightly compress the graduating spring and move the slide valve to full service position.

FULL SERVICE POSITION.

Q. Explain what takes place when the valve moves from quick service position to full service position.

A. As the triple piston moves to the right, slightly compressing the graduating spring, it moves the slide valve until the quick service ports in the slide valve and the ports in the seat are no longer in communication, and the auxiliary service port in the slide valve is brought in full register with the brake cylinder port in the seat, permitting the auxiliary reservoir air to flow to the brake cylinder at the same rate that the brake pipe pressure is being reduced.

Q. Does not air flow through the quick service ports when the valve is in full service position?

A. No. As it requires a prompt fall in brake pipe pressure to cause the valve to move to full service position, the local brake pipe reduction obtained by the quick service ports is unnecessary, therefore this feature is automatically cut out.

Q. Will the air that flows through the quick service ports to the chamber above the emergency piston develop sufficient pressure to force the piston down and cause the triple valve to operate in quick action?

A. No. The emergency piston is sufficiently loose in its cylinder to permit the air that flows through the

small quick service ports to pass readily around the piston to the chamber and to the brake cylinder.

Q. With the triple valve in quick service or full service position, how much air will flow from the auxiliary reservoir to the brake cylinder?

A. That depends on the amount of reduction made in the brake pipe. When the discharge of air from the brake pipe ceases, the auxiliary reservoir pressure will continue to fall until the pressure on the auxiliary side of the triple valve piston is slightly below the pressure remaining on the brake pipe side, when the piston will move to the left, causing the graduating valve to close the auxiliary service port and quick service port in the slide valve.

Q. As the triple piston moves to the left causing the graduating valve to close the service ports, why does it not move the slide valve to release position?

A. The friction of the piston and graduating valve is much less than that of the slide valve, therefore the difference in pressure that will move the piston and graduating valve will not move the slide valve, and the movement of the piston is arrested when the collar on its stem comes in contact with the slide valve.

LAP POSITION.

Q. What is meant by lap position?

A. It is a position of the valve where all ports are lapped; that is, closed.

Q. Is there any difference between quick service lap and full service lap positions?

A. Yes. In quick service lap position the quick service ports in the slide valve are still in register with the quick service ports in the seat, whereas in full service

lap these ports are not in register. As the slide valve does not move, when the triple goes to lap position, it will remain in full service position, but with the graduating valve moved back so as to blank the ports in slide valve.

Q. If a further brake pipe reduction is made, what action will be obtained from the triple valve?

A. It will move to the position it was in before it moved to "lap."

Q. What is the total number of pounds reduction in brake pipe pressure required to fully apply the brake?

A. Twenty pounds with proper brake cylinder piston travel (eight inches).

Q. Why will a reduction of twenty pounds in brake pipe pressure fully apply the brake?

A. Auxiliary reservoirs are so proportioned to the sizes of the brake cylinders that, with an initial pressure of seventy pounds in the brake pipe and auxiliary reservoirs, the pressure in the latter will equalize into brake cylinders at fifty pounds.

Q. What will be the effect if a reduction of more than twenty pounds is made in the brake pipe?

A. It will be a waste of brake pipe air. The triple piston will move the graduating stem, compress its spring and carry the slide valve to emergency position, but no greater brake cylinder pressure will be obtained as the auxiliary reservoir and brake cylinder pressures are already equalized.

Q. With the triple valve in application or lap position, what must be done to cause it to move to release position?

A. The brake pipe pressure must be raised sufficiently to overcome the friction of the piston slide valve.

Q. Explain the action of the triple valve when the brake pipe pressure acting on the piston is great enough to overcome the friction of piston and slide valve.

A. The piston will move to the left carrying with it the slide valve until the end of the piston and stem and slide valve comes in contact with the retarding stem which will arrest their movement and stop them in full release and charging position. The flow of air through the triple valve in this position has been explained heretofore.

RETARDED RELEASE POSITION.

Q. What must be done to cause the triple valve to move to retarded release position?

A. The air pressure on the brake pipe side of the piston must be raised above the pressure on the auxiliary reservoir side of the piston at least three pounds more than that required to overcome the friction of the piston and slide valve. This higher brake pipe pressure will then be sufficient to move the retarding stem and compress its spring until the piston comes in contact with the end of the slide valve bushing.

Q. Explain the flow of air through the triple valve in retarded release and charging position.

A. Brake pipe air, which is always present in the chamber on the right of the triple piston, flows through the feed groove in the bushing over the top of piston and through a small groove cut in the piston seal (at the point in contact with the slide valve bush), to slide valve chamber and the auxiliary reservoir. The exhaust cavity in the slide valve now being in register with the brake cylinder port, its tail port in register with the exhaust port; brake cylinder air will flow through port, cavity

and restricted passage to the tail port, thence through the exhaust port to the atmosphere.

Q. Is the feed groove in the seal of the piston the same size as the feed groove in the bushing?

A. No. This groove is smaller in order that the charging of the auxiliary reservoir will be slower when the triple valve is in retarded release position, than when in full release position.

EMERGENCY POSITION.

Q. What must be done to cause the triple valve to operate in quick action?

A. When the brake pipe pressure on the right of the piston is reduced quickly, and considerably below the auxiliary reservoir pressure on the left, the piston moves quickly to the right, forcing back the graduating stem and compressing its spring, until the piston seats firmly against the cylinder cap gasket. As the slide valve moves with the piston, it opens the cylinder port in the slide valve seat and allows air from the auxiliary reservoir to flow to the top of the emergency piston, forcing it downward and opening the emergency valve. The pressure being thereby instantly reduced, allows brake pipe air to raise the check valve and flow rapidly through to the brake cylinder until brake cylinder and brake pipe pressures nearly equalize, when the check valve is forced to its seat by its spring, preventing the brake cylinder air from flowing back into the brake pipe. At the same time the emergency port in the slide valve, being in register with the brake cylinder port, permits auxiliary reservoir air to flow to the brake cylinder, but the size of these ports is such that comparatively little air gets through them before the brake pipe has stopped venting into the

brake cylinder. The emergency valve being held open by the emergency piston, will return to its seat when the auxiliary and brake cylinder pressures have nearly equalized due to the pressure of the check valve spring under the emergency valve.

Q. What pressure will the auxiliary reservoir and brake cylinder equalize at with an emergency application?

A. With an initial pressure of seventy pounds in the brake pipe and auxiliary reservoir, the auxiliary reservoir and brake cylinder will equalize at approximately sixty pounds.

Q. If one triple valve operates in quick action, does the reduction it makes in brake pipe pressure apply other brakes in quick action?

A. Yes. Each valve causes the next to apply, thus giving a quick and full application of all the brakes throughout the train.

Q. How long a time does it require to apply the brakes in quick action throughout a fifty-car train?

A. About three seconds.

Q. Is the release after an emergency application accomplished the same as after a service application?

A. Yes. But it requires a longer time owing to the higher brake cylinder and auxiliary reservoir pressure and the lower brake pipe pressure.

Q. What is the object of having the triple valve piston make a joint on the cylinder cap gasket when in emergency position?

A. To prevent auxiliary reservoir air from leaking into the brake pipe past the piston.

Q. Is the graduating spring of the same strength as the retarding spring?

A. No. The retarding spring is heavier and stronger than the graduating spring.

MANIPULATION.

Q. Are any special instructions required by engineers regarding the handling of trains partially or wholly equipped with the K triple valve?

A. No; the automatic brake valve should be handled as good practice requires with the H triple valve.

Q. What important detail should be observed when making the terminal tests?

A. The results should be carefully checked by noting how the brakes hold in the first running application, and the engineer should be governed accordingly in subsequent applications.

Q. What rule should be observed relative to release?

A. Before attempting to release, have ample excess pressure for the length of the train, and in releasing leave the automatic brake valve handle in release position until the rear brakes have had time to release.

AUTOMATIC SLACK ADJUSTER.

Q. What is the function of the automatic slack adjuster?

A. It maintains a constant predetermined piston travel, and thus insures that each car performs its share of the work.

Q. Why is it necessary to take up the slack in the brake rigging?

A. On account of the wear of the brake shoes.

Q. Suppose two freight cars, with 8-inch brake cylin-

ders and the same levers, be taken with 5 and 9 inches piston travel respectively. Charge them to 70 pounds pressure and then make a 7-pound train pipe reduction. How would the piston pressures of the two brake cylinders compare?

A. The piston with 5 inches travel would have about 1,150 pounds total pressure, nearly half of a full service application, while the piston with 9 inches travel would have a total pressure of only about 400 pounds—a little more than one-third of the other.

Q. With two cars braking with these different forces, due to unequal piston travel, what would be the piston pressures if a second or further 7-pound train pipe reduction were made?

A. The one with 5 inches travel would be fully applied, at about 2,600 pounds, and the one with 9 inches travel would be about three-fifths set, at about 1,500 pounds.

Q. Suppose a further reduction of 7 pounds, 21 in all, be made?

A. This last reduction would be wasted on the brake with 5 inches piston travel, as it was already fully applied, and the one with 9 inches piston travel would now be about as heavily applied as we could get it; but the total pressure in the cylinder of the latter would be only about 2,300 pounds, or approximately 90 per cent. of the other car.

Q. Then the car with 9 inches piston travel would have a much inferior brake, due to the simple fact that it has a too long piston travel?

A. Yes; it is only 90 per cent. as efficient on the third 7-pound train pipe reduction as the other one, only 60

per cent. on the second 7 pounds, and only 30 per cent. as efficient on the first 7-pound reduction.

Q. How does the automatic adjuster do its work?

A. It adjusts the piston at its proper running or working travel, regardless of the lost travel, or whether the car be high-leveraged or low-leveraged. Thus, if all cars in a train were equipped with automatic slack adjusters, the travel of all pistons would be uniform when brakes were set to slow down or stop the train. The same brake cylinder pressure would be had on all the cars at each reduction.

CONDUCTOR'S VALVE.

Q. What is the conductor's valve and what is it for?

A. It is simply an additional stop cock connected with the train pipe, and by opening it the conductor can apply the brakes in case of emergency.

Q. How is it connected?

A. A branch pipe connecting with the train pipe passes up through the body of the coach, usually in the toilet room, and on this branch pipe is placed the stop cock, or valve.

Q. How should the conductor's valve be handled?

A. If it is desired to make a gradual stop the valve should be opened gradually, but for a quick stop it must be opened quickly and left open until the train is stopped.

TYPE L TRIPLE VALVE.

Q. What is the Schedule LN Equipment?

A. It is an improved brake for high speed passenger service.

Q. In what respect does it differ from the old standard high speed brake equipment?

A. It has additional features necessary for the proper braking of modern trains.

Q. What features has the LN Equipment that were not obtained with the old standard high speed brake equipment?

A. Quick recharge of the auxiliary reservoir, quick service application, graduated release and high emergency brake cylinder pressure.

Q. In a general way how does this schedule differ from the old high speed brake schedule?

A. It has a new type of triple valve and an additional reservoir.

Q. What is the designation of the triple valve?

A. Type L.

Q. Is a high speed reducing valve used with the LN schedule?

A. No; a safety valve, which is a part of the L triple valve, takes the place of the high speed reducing valve.

Q. Does the type L, triple valve operate in harmony with the older standard types of passenger triple valve?

A. Yes; it has all the features of the old types of triple valves in addition to the new features.

Q. Are all of the improved features, such as quick recharge, quick service application, graduated release and high emergency brake cylinder pressure, obtained from the triple valve alone?

A. No; they are obtained through the combination of the improved triple valve and the additional reservoir.

Q. What is this reservoir called?

A. Supplementary reservoir.

Q. What is the size of the supplementary reservoir as compared with the auxiliary reservoir?

A. It is approximately two and one-half times the size of the auxiliary reservoir.

Q. Is the supplementary reservoir volume always confined to one reservoir?

A. No; where space under the car does not permit of using one large reservoir, two supplementary reservoirs having an equivalent capacity are sometimes used.

Q. In addition to the improved operating feature of the L triple valve, has any other improvement been made?

A. Yes; this valve is of the pipeless type, which permits it to be applied or removed from the brake cylinder head without disturbing any of the pipe joints.

Q. What improved features are derived by the use of the LN schedule?

A. (a) A moderate brake cylinder pressure obtained from light brake pipe reductions.
(b) Heavy service reductions can be made quickly without liability of obtaining quick action.
(c) The air pressure can be graduated into or out of the brake cylinder.
(d) The auxiliary reservoir re-charges quickly so as to permit of a prompt response to successive applications.
(e) A high brake cylinder pressure can be obtained quickly from an emergency application.

Q. Name the different parts of the complete LN brake schedule.

A. Type L triple valve with safety valve; type N brake cylinder with pressure head arranged for all pipe connections; auxiliary reservoir and its drain cock; sup-

plementary reservoir and its drain cock; branch-pipe cut-out cock; conductor's valve; angle cocks; air hose and brake pipe fixtures ordinarily found on a car; also the automatic slack adjuster.

Q. What is the purpose of the cut-out cock?

A. It is furnished with this schedule in order that the supplementary reservoir can be cut out during the transition period.

Q. How many sizes of L triple valves are there?

A. Three; designated as follows: L-1, L-2, and L-3.

Q. What sizes of brake cylinders are these valves adapted for?

A. L-1 is for 8-in. and 10-in. brake cylinders; L-2 for 12-in. and 14-in.; and L-3 for 16-in. and 18-in. brake cylinders.

FULL RELEASE AND CHARGING POSITION.

Q. Explain the flow of air through the triple valve in full release and charging position.

A. Air from the brake pipe enters the triple valve and flows through into the chamber on the face of the triple valve piston; thence through feed groove to chamber R and the auxiliary reservoir. Brake pipe air also raises the check valve and flows through ports into the auxiliary reservoir. A port in the slide valve is now in register with the supplementary reservoir into which air also passes. In this way both auxiliary and supplementary reservoirs are charged at the same time with the same pressure. At the same time air from the brake cylinder entering the triple flows through a port in the body, and valve seat, to a port in the slide valve, thence through a cavity in the graduating valve to another port in the slide valve, and thence to the atmosphere.

QUICK SERVICE POSITION.

Q. Explain the operation and flow of air through the triple valve in qiuck service position.

A. With the air pressure equal in the brake pipe, auxiliary reservoir and supplementary reservoir, a service reduction in the brake pipe reduces the pressure on the face of triple valve piston below that in the auxiliary reservoir on the opposite side of the piston. The higher auxiliary reservoir pressure, therefore, forces the piston to the left, which carries with it the graduating valve. This movement of the piston closes the feed port in the bushing and permits the graduating valve to close the ports on the upper side of the slide valve, which closes the communication between the brake pipe and the auxiliary reservoir and supplementary reservoir; also closing the exhaust passage from the brake cylinder to the atmosphere. This same movement opens another port in slide valve and connects two ports through the small cavity in graduating valve. At this time the spider or lugs on the end of the piston stem engage the end of the slide valve, which is carried to the left with the graduating valve until the piston comes in contact with graduating sleeve, which causes it to stop in quick service position.

Q. What particular benefit is obtained by the flow of air from the brake pipe to the brake cylinder through the quick service ports just mentioned?

A. The brake pipe air assists in moving the brake cylinder piston beyond the leakage groove, and at the same time the local reduction made in brake pipe pressure by the triple valve results in the service reduction

being quickly and uniformly transmitted from car to car throughout the train.

Q. Is the amount of air vented from the brake pipe to the brake cylinder through the quick service ports very great?

A. No.

Q. Why?

A. First—because the quick service ports and passages are small, and second—as the piston and slide valve move toward full service position, the quick service port is restricted and is completely closed just before the service port in the slide valve is fully opened.

Q. What governs the amount of opening, and time that the quick service port remains open?

A. The rate of reduction in brake pipe pressure as compared with that of the auxiliary reservoir.

Q. If the brake pipe pressure is reduced quickly, as would be the case with a short train, what will be the result?

A. The higher auxiliary reservoir pressure will move the piston and slide valve promptly to full service position, thereby automatically cutting out the quick service feature when it is not needed.

Q. What will result from a slow brake pipe reduction as with long trains?

A. A slow brake pipe reduction will cause a partial opening of the service port sufficient to reduce the auxiliary reservoir pressure as quickly as the brake pipe pressure is being reduced; therefore, with this port only partly open, a balance of pressure is maintained on the two sides of the triple valve piston.

Q. With the triple valve in quick service position and air flowing from the brake pipe and auxiliary reservoir to

the brake cylinder, why does not the valve remain in this position until the brake is fully applied?

A. The triple valve will remain in quick service position as long as air is being discharged from the brake pipe at the brake valve; when the reduction is stopped, the triple valve will move to quick service lap position, due to the fact that the service port in the slide valve is larger than the quick service port.

Q. With the triple valve in quick service lap position, what action will take place if a further reduction is made in brake pipe pressure?

A. If the brake pipe pressure is reduced slowly, the triple valve piston will again move to the left, carrying with it the graduating valve and opening the service port, and the quick service ports as before mentioned.

Q. Will the air obtained from the brake pipe through the quick service ports cause a considerably higher brake cylinder pressure when the brake is fully applied?

A. No; the gain in cylinder pressure is approximately one pound above that which would be obtained without the use of the quick service feature.

FULL SERVICE POSITION.

Q. What causes the triple valve to move to full service position?

A. When the pressure in the brake pipe is being reduced rather promptly, as would be the case with a short train or a train having considerable brake pipe leakage, the triple valve piston will move to the left, coming in contact with the graduating sleeve, moving it slightly and compressing the graduating spring. By this movement the service port in the slide valve is brought in full register with the brake cylinder port in the seat, permit-

ting auxiliary reservoir pressure to flow to the brake cylinder at the same rate at which the brake pipe pressure is being reduced.

Q. If the brake pipe reduction is less rapid than is required to fully open the port, what takes place?

A. This port is only partially opened, but sufficient to preserve a balance between the pressures on the two sides of the triple valve piston.

Q. How much air will leave the auxiliary reservoir and flow to the brake cylinder when the triple valve moves to full service position?

A. Approximately the same reduction in pressure as was made in the brake pipe.

Q. Is not the safety valve connected with the brake cylinder in all positions of the triple valve?

A. No; it is connected in all, except emergency position, as will be explained later.

Q. What pressure is the safety valve set for?

A. Sixty-two pounds.

Q. As this valve is connected to the brake cylinder during service operation of the triple valve, does it not answer the same purpose as the high speed reducing valve?

A. Yes; it limits the maximum pressure that can be obtained in the brake cylinder from service applications to an amount not liable to cause wheels to slide.

Q. When the triple valve is in quick service or full service positions, does not air from the supplementary reservoir flow to the brake cylinder in addition to the auxiliary reservoir air?

A. No.

Q. Why?

A. The supplementary reservoir is cut off when the

triple valve is in quick service, full service or lap positions; therefore, this reservoir pressure will be retained.

LAP POSITION.

Q. What will cause the triple valve to move from service position to lap position?

A. After sufficient brake pipe reduction has been made to produce the desired application, and the brake valve handle is placed in lap position, a further escape of air from the brake pipe is prevented. When the flow of air from the auxiliary reservoir to the brake cylinder has reduced the pressure on the auxiliary side of the piston slightly below that remaining on the brake pipe side, the greater pressure on the brake pipe side, assisted by the graduating spring, will move the piston and graduating valve to service lap position.

Q. As the triple valve piston and graduating valve move from service position to service lap position, what prevents the piston from continuing its movement to release position?

A. As the triple valve piston and graduating valve move to service lap position, the shoulder on the stem of the piston comes in contact with the end of the slide valve. The slightly higher pressure acting on the brake pipe side of the piston, which was sufficient to move it and the graduating valve, is not sufficient to overcome the added resistance of the slide valve and the parts remain in the position shown.

Q. With the triple valve in service lap position, are there any ports or passages open?

A. No; except that the safety valve is still in register with the brake cylinder.

Q. Is there any difference between quick service lap and full service lap?

A. Yes. The position of the slide valve is not the same as in quick service position.

Q. After the triple valve has moved to lap position, following a service reduction, what parts move on a further brake pipe reduction?

A. The piston and graduating valve when the brake pipe pressure is reduced at approximately the same rate as the first reduction.

Q. With the triple valve in service lap position, what must be done to cause the valve to move to release position?

A. The pressure in the brake pipe must be raised higher than the pressure in the auxiliary reservoir.

Q. How can the brake pipe pressure be made greater than the auxiliary reservoir pressure?

A. By placing the engineer's brake valve in running or release position, and permitting air to flow from the main reservoir to the brake pipe, or by opening the drain cock on the auxiliary reservoir.

RELEASE POSITION.

Q. Explain the action of the triple valve and the flow of air through it when moved from service lap position to release position.

A. When the brake pipe pressure is raised above that in the auxiliary reservoir, the triple valve piston will move to the right, carrying with it the slide valve and graduating valve to full release and charging position. In this position the air in the brake cylinder is exhausted through the slide valve, graduating valve and passage to the atmosphere. At the same time the auxiliary reser-

voir is being re-charged from the brake pipe through the feed groove and ports, as previously described. The air in the supplementary reservoir which remained at its initial pressure when the triple valve moved to service position will now flow into the auxiliary reservoir and help re-charge it, resulting in a quick re-charge.

Q. What is the benefit of having the auxiliary reservoir quickly re-charged?

A. It insures an immediate response of the triple valve to a brake pipe reduction, should it be necessary to make a second brake application.

Q What must be done to insure that the triple valve will move to full release position and remain there, exhausting all air from the brake cylinder?

A. The brake pipe pressure must be fully restored and the auxiliary reservoir, and supplementary reservoir will be fully re-charged.

Q. What will be the result if only sufficient air is admitted to the brake pipe, to move the triple valve to release position, and the brake valve handle is then moved to lap position?

A. The flow of air from the supplementary reservoir to the auxiliary reservoir continuing after the rise in brake pipe pressure has ceased, will raise the pressure on the auxiliary reservoir side of the triple valve piston slightly above that on the brake pipe side, which will cause the piston and graduating valve to move to graduated release lap position.

Q. What ports are closed when the piston and graduating valve move to graduated release lap position?

A. The graduating valve closes the exhaust port thus preventing further flow of air from the brake cylinder to the atmosphere.

Q. How much air will be retained in the brake cylinder when the triple valve moves to graduated release lap position?

A. This will depend upon the original amount of air pressure in the brake cylinder; also the amount that was permitted to escape when the triple valve was in release position.

Q. When the triple valve moves to graduated release lap, does the slide valve move?

A. No; only the triple valve piston and graduating valve.

Q. With the triple valve in graduated release lap, what must be done to cause it to move to release position?

A. The brake pipe pressure must again be raised above that in the auxiliary reservoir, as previously described.

Q. Can more than one graduation of the triple valve be had?

A. Yes; the brake cylinder pressure can be reduced by a series of steps or graduations until the brake pipe pressure has been fully restored and the exhaust of air from the brake cylinder completed.

Q. What governs the amount of reduction in brake cylinder pressure during graduations?

A. The amount of air pressure which has been restored in the brake pipe.

Q. Is the re-charge of the auxiliary reservoir influenced by the rise in brake pipe pressure?

A. Yes; the re-charge of the auxiliary reservoir is in proportion to the rise in brake pipe pressure.

EMERGENCY POSITION.

Q. With the triple valve in release position, and the auxiliary reservoir and supplementary reservoir charged, what must be done to cause the valve to move to emergency position?

A. The brake pipe pressure must be reduced quickly or more rapidly than the auxiliary reservoir pressure can flow through the service ports of the triple valve, which will result in the piston being forced quickly to the left, its full stroke, moving with it graduating sleeve, and compressing graduating spring.

Q. Explain the flow of air through the triple valve when in emergency position.

A. Air from the auxiliary reservoir enters the brake cylinder through a port in the slide valve and passage. Another port in the slide valve seat is uncovered by the end of the slide valve, admitting air from the auxiliary reservoir, through this port to the top of the emergency piston, forcing it down, which unseats the rubber-seated emergency valve. This permits brake pipe air to lift the check valve and flow through to the brake cylinder. At the same time a port in the slide valve registers with another port in the seat, thus allowing air from behind the by-pass piston to flow to the brake cylinder, in which there is no pressure at this instant. The by-pass piston and valve are forced to the left by auxiliary reservoir pressure acting on the right side of the piston. Air in the supplementary reservoir then flows past the by-pass valve into the passage leading to the auxiliary reservoir, thereby increasing the volume of air available three and one-half times the size of the volume used in service applications. Air from the supplementary reservoir continues to flow to the auxiliary reservoir until the pres-

sure in the latter reservoir, and the pressure in the brake cylinder nearly equals the pressure remaining in the supplementary reservoir, when the by-pass valve returns to its seat, and closes communication between the two reservoirs.

Q. What pressure will thus be obtained in the brake cylinder?

A. Pressure in the brake cylinder will rise to within a few pounds of the maximum brake pipe pressure.

Q. With the brake fully applied in emergency position will not the air in the brake cylinder reduce through the safety valve?

A. No; for the reason that there is no communication between the brake cylinder and the safety valve during an emergency application.

SAFETY VALVE FOR L TRIPLE.

Q. What is the function of the safety valve?

A. To prevent abnormal brake cylinder pressure during service applications of the brake.

Q. When is the safety valve in connection with the brake cylinder?

A. At all times, except when the triple valve is in emergency position.

Q. How many adjustments has the safety valve?

A. Two; maximum and minimum.

Q. Explain the action of the safety valve.

A. As air from the safety valve port in the triple valve enters the chamber below the safety valve, and its pressure becomes sufficient to overcome the tension of the valve spring the valve is moved upward closing the upper ends of the ports in the valve bushing, and opening the chamber to the atmosphere through ports in the body,

thereby permitting the surplus air to escape. As the air pressure under the valve decreases, the tension of the spring forces the valve downward which action restricts the opening through the ports leading to the atmosphere, and also opens the ports through the bushing thus permitting air to enter the spring chamber above the valve, and this pressure added to the tension of the spring forces the valve to its seat quickly. As the chamber above the valve is open to the atmosphere at all times through small ports in the body, the air which has entered will escape after the valve is again seated. This action causes the valve to open, and close quickly with a pop action.

Q. What is the function of the exhaust regulating ring?

A. To regulate the size of opening through the ports in the valve body.

Q. Why is such regulation necessary?

A. To control the range between opening and closing of the safety valve.

Q. What is the purpose of the lock ring?

A. To hold the exhaust regulating ring securely in its proper position.

Q. How is the safety valve adjusted?

A. By means of the regulating nut on top of the spring.

Q. How is this nut secured in place?

A. By the cap nut.

Q. What pressure should this safety valve be adjusted to open at?

A. Sixty-two pounds.

Q. At what pressure should it close?

A. Fifty-eight pounds.

Q. How is the range between opening and closing regulated?

A. By screwing the regulating ring up or down until the exhaust ports have the proper area of opening to cause the valve to close at fifty-eight pounds.

TRIPLE VALVE DISORDERS AND REMEDIES THEREFOR.

Q. How often should a triple valve be cleaned?

A. Once in three months.

Q. What kind of lubricant should be used?

A. A special lubricant made for the purpose.

Q. What method should be pursued in the cleaning and repair of triple valves?

A. They should be removed from the cars, and the work done in the shop.

Q. Before applying a triple valve to a brake cylinder what should be done?

A. The piping should be thoroughly hammered and blown out in order to remove all scale and foreign matter.

Q. In applying a triple valve to a brake cylinder, should the gasket be placed on the brake cylinder head or on the face of the triple valve?

A. On the face of the triple valve in all cases.

Q. Should the safety valve be cleaned and tested when the triple valve is cleaned and tested?

A. Yes; and the safety valve strainer should also be cleaned.

Q. Should the operating parts of the safety valve be lubricated?

A. No.

Q. What is the most prolific cause of disorders in a triple valve?

A. Dirt or foreign matter getting into the triple valve or the valve becoming dry.

Q. What will cause a blow from the exhaust port of the triple valve?

A. A leaky slide valve, leaky graduating valve, leaky emergency valve, leaky check valve case gasket or a leaky triple valve body gasket.

Q. What air is escaping to the atmosphere when a blow exists at the triple valve exhaust port?

A. Brake pipe or auxiliary reservoir air, depending on what particular part of the valve is leaking.

Q. Name the different parts that would cause a leak from the auxiliary reservoir.

A. The slide valve, graduating valve, or body gasket.

Q. What parts, if defective, would cause a brake pipe leak?

A. The emergency valve rubber seat or the check valve case gasket.

Q. How can the source of leakage in triple valves be determined without removing the valve from the car?

A. By cutting out the brake. If the brake applies and the blow stops, it indicates a leak from the brake pipe. If the blow continues and the brake does not apply, it indicates a leak from the auxiliary reservoir.

Q. Will a leak from the brake pipe to the atmosphere through the triple valve when in release position cause a blow when the brake is applied?

A. No; with the brake applied, the exhaust port is closed.

Q. If a blow at the triple valve exhaust port is due to an auxiliary reservoir leak, will the blow continue after the brake is applied?

A. That depends on what part of the triple valve is

defective. A leaky slide valve will usually cause a blow when the slide valve is in either release or application position. This might also be true of the graduating valve, while a leaky body gasket will only cause a blow when the triple valve is in release position.

Q. What is the effect of a leak by the emergency valve or check valve case gasket?

A. It is a waste of brake pipe air when the brake is not applied. When the brake is applied it causes the brake cylinder pressure to build up or equalize with the brake pipe pressure, which, with light application, may result in giving greater braking power than is desired.

Q. What is the effect of a leak from the auxiliary reservoir?

A. It is a waste of air and tends to release the brake after it has been applied.

Q. Why will not a leaky body gasket cause a blow from the exhaust port when the triple valve is in application position?

A. In this position the exhaust port is closed. Such air as may leak by the gasket will flow to the brake cylinder.

Q. What is wrong with a triple valve if a buzzing or humming sound is heard within the valve after the auxiliary reservoir is charged?

A. This is due either to a leaky emergency valve or leakage from the auxiliary or supplementary reservoirs.

Q. What is the usual effect if the triple valve becomes dry and gummy?

A. It tends to destroy the sensitiveness of the valve to graduated applications and release.

Q. What is the cause of a triple valve operating in quick action during service brake applications?

A. The triple valve may be dry or gummy, or the brake pipe pressure reduces through a leakage at too rapid a rate.

Q. Would a weak or broken graduating spring cause a triple valve to operate in undesired quick action?

A. It may and may not, depending entirely on the condition of the triple valve and the rate of brake pipe reduction.

Q. What is the effect if the triple valve piston packing ring is not a good fit in its cylinder?

A. It will allow air from the brake pipe to pass by the piston into the auxiliary reservoir and may cause the brake to fail to release.

Q. What is the effect if the triple valve piston does not make a good joint against the cylinder cap gasket when in emergency position?

A. In order for the piston to reach the gasket it is necessary to have the brake pipe pressure below that in the auxiliary reservoir; therefore, if a good joint is not made, auxiliary reservoir air can leak by the piston into the brake pipe.

Q. What will result from check valve leakage with the brake applied?

A. It will permit the brake cylinder and auxiliary reservoir air to leak back into the brake pipe whenever the brake pipe pressure is reduced below an equalized pressure in the brake cylinder and auxiliary reservoir, regardless of whether the brake has been applied in service or emergency.

Q. Is check valve leakage as detrimental with the L triple valves in emergency applications as with the older types of triple valves?

A. No; owing to the great volume of air in the com-

bined reservoirs, it would take considerable time and leakage to make any material reduction in the reservoir pressure.

Q. What would be the effect of a leak by the by-pass valve?

A. It would permit supplementary reservoir air to flow to the auxiliary reservoir during service applications and might result in a heavier brake application than was desired during light applications.

Q. How can the by-pass valve be tested for leakage?

A. With the brake pipe, auxiliary reservoir and supplementary reservoir charged to 70 pounds, the brake pipe pressure should be reduced 20 pounds, which will cause equalization between the auxiliary reservoir and brake cylinder at about 50 pounds. Brake cylinder pressure should then be noted and, if it increases, the increase is due to leakage by the by-pass valve into the auxiliary reservoir and brake cylinder.

Q. When quick action triple valves have a continuous blow from the exhaust port, how can it sometimes be stopped?

A. By jarring the triple valve slightly near the emergency valve. Should this not stop the blow, apply the brake in quick action by parting the hose and opening the angle cock quickly, then release the brake and repeat the operation if necessary. This may dislodge the dirt and allow the emergency valve to seat properly.

Q. Should neither of these remedies prove effective, what should be done?

A. The brake should be cut out and the auxiliary reservoir and supplementary reservoir drain cocks opened and left in that position.

Q. If the triple valve fails to graduate the release of the brake, what is the cause?

A. A dry or gummy valve or leakage from the supplementary reservoir.

OPERATING THE LN EQUIPMENT.

Q. Are any special instructions required for handling a train in which are a few cars equipped with LN equipment and the remainder old style brake equipment?

A. No; the brakes should be handled in the ordinary way.

Q. During a service application, will the blow from the brake valve exhaust be as long if a number of LN equipments are in the train?

A. No; it will be shorter from the fact that a portion of the brake pipe air is flowing to the brake cylinders through the quick service ports of the L triple valves.

Q. What is the total number of pounds reduction in brake pipe pressure required to fully apply the brake when 70 pounds brake pipe, auxiliary and supplementary reservoir pressure is carried?

A. About 20 pounds with proper brake cylinder piston travel (8 inches).

Q. Why will a reduction of 20 pounds in brake pipe pressure fully apply the brakes?

A. Auxiliary reservoirs are so proportioned to the sizes of the brake cylinders that with an initial pressure of 70 pounds in the brake pipe, and reservoirs, the pressure in the auxiliary reservoir will equalize into the brake cylinder at about 50 pounds.

Q. What will be the effect if a reduction of more than 20 pounds is made in the brake pipe?

A. It will be a waste of air. The triple valve piston

will move the graduating stem sleeve compressing the graduating spring and carry the slide valve to emergency position, but no greater brake cylinder pressure will be obtained, as the auxiliary reservoir and brake cylinder pressures are already equalized.

Q. When the triple valve moves to emergency position from an over brake pipe service reduction, does not the supplementary reservoir air flow to the auxiliary reservoir?

A. No; as the by-pass valve does not operate in this case.

Q. Is it more difficult to release a brake after the brake pipe pressure has been reduced below equalization than would be the case if the brake pipe and auxiliary reservoir pressures were equal?

A. Yes; as it will be necessary to raise the brake pipe pressure up to that in the auxiliary reservoir in addition to the added amount required to overcome the friction of the triple valve piston and slide valve.

Q. Is it more difficult to release the brake after an emergency application than after a service application?

A. Yes; with a full service application about 50 pounds would remain in the auxiliary reservoir, which would have to be overcome when moving the triple valve to release position; whereas, after an emergency application, the auxiliary reservoir pressure, being considerably higher, would necessarily require a much higher brake pipe pressure to move the triple valve to release position.

Q. Can the release of air from the brake cylinder be graduated after an emergency application?

A. No.

Q. Why?

A. Because the auxiliary reservoir and supplementary reservoir pressures are equal.

Q. If one triple valve operates in quick action, does the reduction it makes in brake pipe pressure apply other brakes in quick action?

A Yes; each valve causes the next to apply, thus giving a quick and full application of all the brakes throughout the train.

Q. If either 90 or 110 pounds brake pipe and auxiliary reservoir pressure is carried, how much of a reduction in brake pipe pressure is required to raise the brake cylinder pressure up to the adjustment of the safety valve?

A. About 25 pounds.

Q. Will any greater brake cylinder pressure be obtained with a 20-pound brake pipe reduction from 110 pounds initial pressure than would be the case with 70 pounds brake pipe pressure?

A. No; approximately the same brake cylinder pressure would be had.

Q. What is the proper method of stopping a train fully equipped with LN brake equipment?

A. When the speed of the train is high, a 20 to 25 pound brake pipe reduction should be made, which will develop maximum service brake cylinder pressure and, as the speed of the train reduces, the brake cylinder pressure should be graduated off by movements of the brake valve handle from lap to running position and back to lap; thereby reducing the brake cylinder pressure as the speed of the train is being reduced, the effort being to have nearly all brake cylinder pressure discharged at the moment the train comes to rest.

Q. Can the brake be re-applied promptly after a release?

A. Yes; owing to the quick re-charge feature, a prompt response will be had to any brake pipe reduction.

Q. If the brake pipe, auxiliary reservoir and supplementary reservoirs are over-charged, how can the pressure be reduced to normal?

A. By making three or four full service applications and releases of the brake, or by bleeding with the auxiliary and supplementary reservoir drain cocks.

Q. If the brake is applied with a service application, can it be bled off by reducing the air pressure in the supplementary reservoir?

A. Yes; by reducing the supplementary reservoir pressure sufficiently below that in the auxiliary reservoir to permit the by-pass valve to unseat. The auxiliary reservoir air will then flow into the supplementary reservoir and reduce to an amount sufficient to cause the brake pipe pressure to move the triple valve to release position.

Q. Should the supplementary reservoir drain cock be used in bleeding off brakes?

A. This may be done, but it is more desirable to do so with the drain cock in the auxiliary reservoir.

Q. In bleeding off a brake with the drain cock in the auxiliary reservoir, if the same is closed at the instant the triple valve moves to release position, what might be expected?

A. The triple valve may graduate and only exhaust a portion of the air from the brake cylinder, due to the air from the supplementary reservoir flowing into the auxiliary reservoir when the triple valve is in release position, causing it to move to graduated release lap position.

Q. What must be done to insure that the triple valve will remain in release position when bleeding off the brake?

A. The auxiliary reservoir pressure should be reduced a considerable amount, and it should be observed that the piston returns into the brake cylinder.

Q. Can a brake be bled off by opening the drain cocks in the auxiliary or supplementary reservoirs when the brake pipe is empty?

A. As a general rule it cannot, the triple valve being in emergency position. When the auxiliary reservoir pressure is reduced sufficiently to permit the graduating spring to move the triple valve piston and slide valve to emergency lap position, communication is closed between the brake cylinder and the auxiliary reservoir, and such air as is then in the brake cylinder would remain, unless the graduating valve lifted from its seat, which is rarely the case.

Q. When cars are to be set out in a yard, what is the proper manner for releasing the brake?

A. The drain cock in the auxiliary reservoir should be opened while there is air remaining in the brake pipe.

Q. If, when releasing the brake, air exhausts from the triple valve until the brake cylinder is empty, but the brake piston fails to return to release position, what does it indicate??

A. That the triple valve moved to release position properly, but the brake piston or the rods and levers are bound in some manner.

Q. Is a retaining valve necessary on a car equipped with the LN equipment?

A. Not when all cars in the train are equipped with LN equipment, but during the transition period when both LN and old-style equipment are in the train the graduated release feature is not used and retaining valves are required.

QUESTIONS AND ANSWERS ON NO. 6 ET LOCOMOTIVE BRAKE EQUIPMENT.*

Q. What is the No. 6 ET Equipment?

A. It is a brake equipment for engine and tender adapted to all kinds of engines and classes of service and combines the operative features of the standard automatic, straight-air, high-speed, and double-pressure control brake equipments, with many additional features.

Q. Is the operation of the train brakes affected by the ET Equipment?

A. No; the operation of the train brakes is the same with this equipment as with former locomotive brake equipments.

Q. What is meant by the term *train* brakes?

A. All brakes in the train except those upon the locomotive from which the brakes are being handled.

Q. What is meant by the term *locomotive* brake?

A. The brake upon the engine and tender.

Q. What new features of operation are obtainable with the ET Equipment?

A. (a) Locomotive brake may be used with or independently of the train brakes, whether the train brakes are in use or not.

(b) Uniform and proper cylinder pressure is obtained regardless of piston travel or leakage.

(c) Cylinder pressure is automatically maintained regardless of brake cylinder leakage.

(d) Locomotive brake can be graduated on or off.

*Formulated by the Air Brake Association.

with either the automatic or the independent brake valves.

(e) Increased flexibility in service operations, with increased braking power in emergency applications.

(f) Brakes on second locomotive or helper can be released or applied without in any way interfering with any other brakes in the train.

PARTS OF THE EQUIPMENT.

Q. Name the essential parts of the ET Equipment.

A. 1, Air Compressor; 2, Main Reservoir; 3, Duplex Pump Governor; 4, Feed Valve; 5, Reducing Valve; 6, Automatic Brake Valve with Equalizing Reservoir; 7, Independent Brake Valve; 8, Distributing Valve and Double Reservoir; 9, Two Duplex Air Gages; 10, Combined Air Strainer and Check Valve; 11, Choke Fitting; 12, Locomotive Brake Cylinders; also various cocks and fittings.

Q. What special parts are sometimes used?

A. (a) Quick-action Cylinder Cap for Distributing Valve.

(b) Combined Air Strainer and Check Valve for Train Air Signal System.

(c) Choke Fitting for Truck Brake.

Q. What furnishes the compressed air for the brake system?

A. The Air compressor.

Q. What operates the air compressor?

A. Steam from the locomotive boiler.

Q. After leaving the compressor, where does the air go?

A. Through the radiating pipes to the main reservoir.

Q. What is the purpose of the radiating pipe?

A. To cool the air after leaving the compressor.

Q. What is the purpose of the main reservoirs?

A. The main reservoirs provide a place for the storage of an abundant supply of compressed air for use in promptly releasing the brakes on the locomotive and train and for recharging the brake system. They also assist in cooling the compressed air and collect moisture, oil or other foreign matter, allowing only clean, dry air to pass to the brake system.

Q. What controls the air pressure in the main reservoirs?

A. The Duplex pump governor.

Q. How does the pump governor control the main reservoir pressure?

A. It automatically regulates the supply of steam to the compressor so as to maintain normal pressure in the main reservoirs.

Q. What connects the main reservoirs to the brake system?

A. The main reservoir pipe.

Q. What provision is made for cutting off the main reservoirs from the rest of the brake system?

A. A cock in the main reservoir pipe close to the main reservoir, known as the "main reservoir cut-out cock."

Q. Where do the pipe branches lead to from the main reservoir pipe?

A. (a) To the duplex pump governor.

(b) To the main reservoir hand of the duplex air gage.

(c) To the automatic brake valve.

(d) To the feed valve.
(e) To the reducing valve.
(f) To the distributing valve.
(g) To the dead engine fixtures.
(h) Other branches leading to various air-using devices on the locomotive, such as sanders, water-scoop, etc.

Q. What is the purpose of the feed valve?

A. To automatically maintain a predetermined pressure in the brake system, lower than that carried in the main reservoirs.

Q. To what does the feed valve pipe connect?

A. To the automtaic brake valve, and to the spring chamber of the excess pressure head of the duplex pump governor.

Q. What is the purpose of the reducing valve?

A. It automatically reduces the air pressure from the main reservoirs to the proper pressure used with the independent brake, and train air signal system.

Q. What is the purpose of the automatic brake valve?

A. (a) To allow air to flow from the brake system for charging it.

(b) To discharge air from the brake pipe to the atmosphere to apply the brakes.
(c) To prevent the flow of air to, or from the brake pipe when holding the brakes applied.
(d) To hold applied, or release the locomotive brake as desired while releasing train brakes.
(e) To allow air to flow to the brake system for the purpose of releasing the brakes and recharging the system.
(f) To control the flow of air to the diaphragm

chamber of the excess pressure head of the duplex pump governor.

(g) To allow main reservoir air to flow to the application cylinder of the distributing valve in *emergency* position.

Q. What is the purpose of the independent brake valve?

A. To operate the brakes on the engine and tender, independent of the train brakes.

Q. State briefly the purpose of the distributing valve.

A. (a) To automatically control the flow of air from the main reservoirs to the engine and tender brake cylinders when applying the brakes.

(b) To automatically maintain the brake cylinder pressure against leakage, keeping it constant, when holding the brake applied.

(c) To automatically control the flow of air from the engine and tender brake cylinders to the atmosphere when releasing the brake.

Q. What is the purpose of the brake cylinders?

A. The brake cylinder is that part of the air brake equipment in which the force contained in the compressed air is transformed into a mechanical force which is transmitted through a suitable combination of rods and levers to the brake shoes and applies them to the wheels.

H-6 AUTOMATIC BRAKE VALVE.

Q. How many positions has the H-6 Brake Valve?

A. Six.

Q. Name the positions beginning at the left.

A. *Release, Running, Holding, Lap, Service* and *Emergency.*

Q. Name and describe the purpose of the pipe connections to the H-6 Brake Valve.

A. (a) Main Reservoir Pipe. To connect the main reservoirs to the chamber above the rotary valve and permit a free flow of high pressure air into the brake pipe when the brake valve handle is in *release* position.

(b) Feed Valve Pipe. To connect the feed valve to the underside of the rotary valve. When the brake valve handle is in *running* position this pipe is open to the brake pipe, thus permitting the feed valve to maintain a constant brake pipe pressure below that in the main reservoirs.

(c) Equalizing Reservoir Pipe. This connects the chamber above the equalizing piston to the equalizing reservoir and the equalizing reservoir gage.

(d) Brake Pipe. To connect the distributing valve on the locomotive and the triple valve on each car to the space underneath the equalizing discharge piston and the underside of rotary valve.

(e) Governor Pipe. This makes a connection from the rotary valve chamber (main reservoir pressure) to the underside of the diaphragm of the excess pressure governor head when the brake valve handle is in either *release, running* or *holding* positions.

(f) Distributing Valve Release Pipe. This makes a connection from the application chamber

of the distributing valve (through the independent brake valve) to the underside of the automatic rotary valve, forming a connection to the atmosphere when both brake valve handles are in *running* position.

(g) Application Cylinder Pipe. This connects the underside of the automatic rotary valve directly to the application cylinder of the distributing valve. In *emergency* position of the brake valve handle this pipe is open to the chamber above the rotary valve (main reservoir pressure) through the blow-down timing port.

Q. When is *release* position used?

A. When it is desired to quickly charge the brake system and to release brakes on long trains.

Q. Explain the flow of air through the automatic brake valve when in *release* position.

A. Air from the main reservoirs flows directly to the brake pipe, equalizing reservoir and pump governor. Air from the feed valve flows through the warning port to the atmosphere.

Q. When is *running* position used?

A. When running along the road to maintain a predetermined brake pressure lower than that carried in the main reservoirs, to release the engine and tender brakes and also to release the brakes on short trains.

Q. Explain the flow of air through the automatic brake valve when in *holding* position.

A. (a) Air from the feed valve flows to the brake pipe and to the equalizing reservoir.

(b) Air from the main reservoirs flows directly to the diaphragm chamber of the excess

pressure head of the duplex pump governor.

(c) Air from the distributing valve release pipe flows to the atmosphere.

Q. When is *holding* position used?

A. When it is desired to hold the engine and tender brakes applied by means of the automatic brake valve, while releasing and recharging the train brakes.

Q. Explain the flow of air through the automatic brake valve when in *holding* position.

A. The flow of air through the automatic brake valve when in holding position is the same as when in *running* position with one exception, namely: air from the distributing valve release pipe is prevented from flowing to the atmosphere.

Q. When is *lap* position used?

A. When holding all the brakes applied after an automatic application. The handle should never be carried in this position except while bringing the train to a stop.

Q. Is there any flow of air to the brake system through the automatic brake valve when in *lap* position?

A. No.

Q. When is *service* position used?

A. When it is desired to make an automatic application of the brakes.

Q. Explain fully the flow of air through the automatic brake valve when in *service* position.

A. In the automatic brake valve is a piston and valve called the equalizing discharge piston and valve, No. 15. See Figure 1. The underside of this piston is directly connected to the brake pipe. The chamber *D*, above piston 15, is directly connected to the equalizing reservoir *ER* and to a small port *e* in the

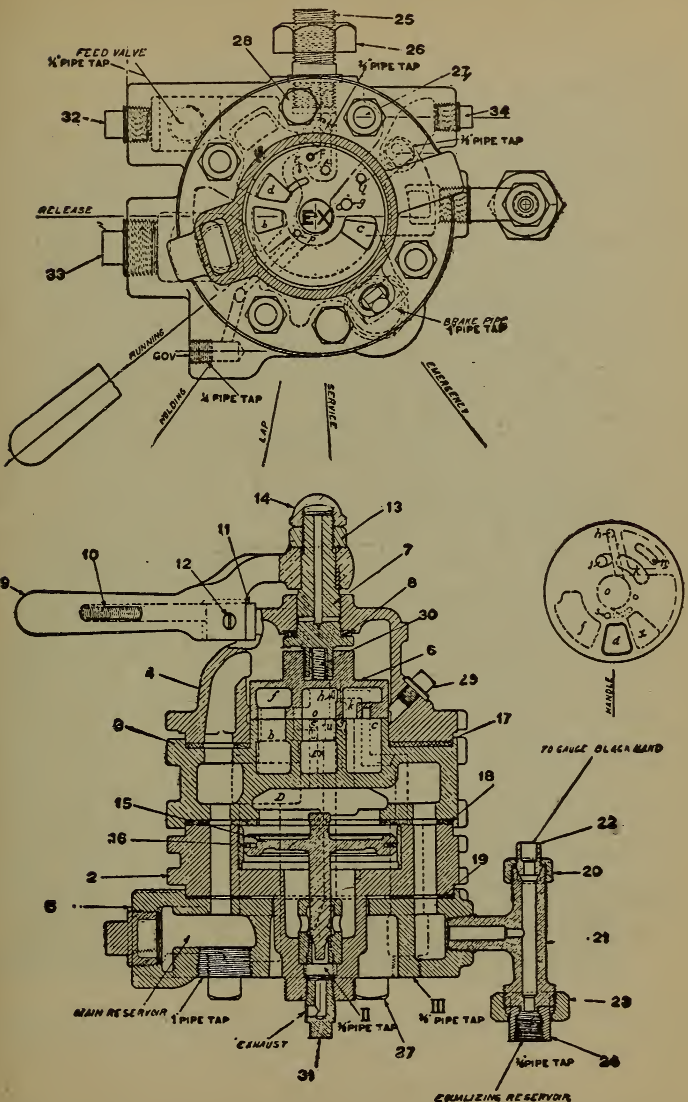


Fig. 1—The H-6 Automatic Brake Valve. Cross Section.

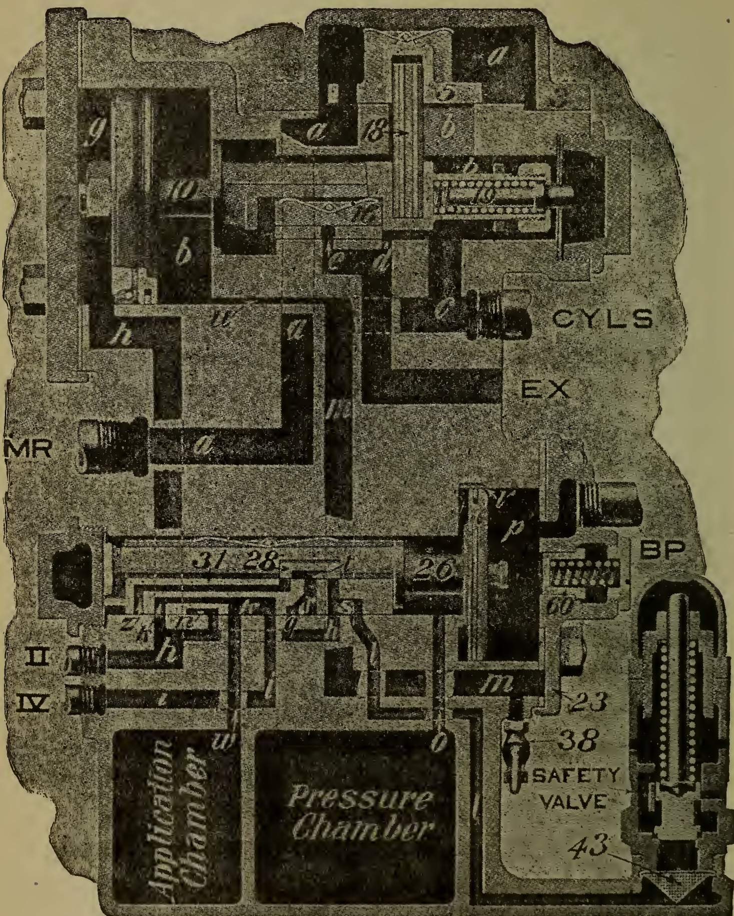


Fig. 2—No. 6 Distributing Valve Release Position, Automatic or Independent.

CONNECTIONS:

MR—Main-Reservoir Pipe; IV—Distributing-Valve Release Pipe; II—Application-Cylinder Pipe; CYLS—Brake-Cylinder Pipe; BP—Brake Pipe.

rotary valve seat called the preliminary exhaust port. In *service* position the preliminary exhaust port is open to the atmosphere through port *h* and exhaust cavity *o* (see small view plan of Rotary Valve at right, see Fig. 1), in the rotary valve, thus allowing air from the equalizing reservoir and the chamber *D* above the equalizing discharge piston to flow to the atmosphere. This reduces the pressure on the top of the piston below the brake pipe pressure on the underside, which raises the equalizing discharge piston 15 and permits brake pipe air to flow to the atmosphere through the service exhaust fitting *B. P. Ex.* The flow of air from the equalizing reservoir to the atmosphere continues until the brake valve handle is returned to *lap* position. This closes the preliminary exhaust port *e*, and prevents further decrease of pressure in the equalizing reservoir and chamber *D*. Air will continue to discharge from brake pipe until its pressure has been reduced slightly lower than that remaining in chamber *D*. The higher pressure on the top of the piston then forces the valve to its seat and prevents further reduction of brake pipe pressure.

Q. What is the purpose of the service exhaust fitting?

A. To fix the maximum permissible opening from the brake pipe to the atmosphere when making a service application.

Q. Is it important that all H-6 brake valves be provided with this fitting?

A. Yes.

Q. When is *emergency* position used?

A. When it is desired to make the shortest possible stop. In such case the handle should be moved to

emergency position quickly and left there until the train stops.

Q. Should this position be used at any other time?

A. Yes; this position should be used in case of an emergency application of the brakes from an unknown cause, such as the opening of a conductor's valve, bursted hose, etc., in order to prevent loss of main reservoir pressure and to insure a full application of the brakes, and the handle should be left there until signal to release is given.

Q. Why should *emergency* position be used as explained in the last answer instead of *lap* position?

A. To insure the brakes remaining applied under all circumstances.

Q. Explain the flow of air through the automatic brake valve when in *emergency* position.

A. A large and direct opening is made from the brake pipe to the atmosphere, through the rotary valve, causing a quick and heavy reduction of brake pipe pressure. At the same time the air in the equalizing reservoir escapes to the atmosphere through ports in the rotary valve. Connection is made from air at main reservoir pressure above the rotary valve through a restricted port in the rotary valve to the application cylinder pipe leading to the application cylinder of the distributing valve. This port is known as the blow-down timing port, and assists in building up and regulating application cylinder pressure during emergency application.

S-6 INDEPENDENT BRAKE VALVE.

Q. How many positions has the S-6 Brake Valve?

A. Five.

Q. Name the positions beginning at the left.

A. *Release, Running, Lap, Slow-Application* and *Quick-Application.*

Q. Name and describe the purpose of the pipe connections to the S-6 Brake Valve.

A. (a) Reducing Valve Pipe. This is the only source of air supply to the valve and connects the reducing valve to the chamber above the rotary valve, and through the rotary valve when the independent brake valve handle is in either *application position,* to the application cylinder and chamber of the distributing valve and also through the warning port to the atmosphere when the handle is in *release* position.

(b) Distributing Valve Release Pipe *to the distributing valve.* Connects the application chamber of the distributing valve to the underside of the independent brake valve. When the brake valve handle is in *running* position, this pipe is connected through ports in the seat and cavities in the rotary valve to the automatic brake valve.

(c) Distributing Valve Release Pipe to the *automatic brake valve.* This pipe connects the underside of the rotary valve of the independent brake valve to the underside of the rotary valve of the automatic brake valve. With both brake valve handles in *running* position, free passage is made from the application chamber of the distributing valve to the atmosphere through this pipe.

(d) Application Cylinder Pipe. Connects the application cylinder to the underside of the

rotary valve of the independent brake valve. When the handle is in either *application* position, air from above the rotary valve flows through this pipe to the application cylinder and chamber of the distributing valve. When the handle is in *release* position this pipe is connected to the atmosphere through ports in the rotary valve and seat.

Q. When is *release* position used?

A. Whenever it may be necessary to release the brake when the automatic brake valve handle is not in *running* position.

Q. Explain the flow of air through the independent brake valve when in *release* position.

A. Air from the application cylinder of the distributing valve flows direct through the application cylinder pipe and independent brake valve to the atmosphere. At the same time air from above the rotary valve (reducing valve pressure) flows through the rotary valve and warning port to the atmosphere.

Q. When is *running* position used?

A. When running along the road and to release the locomotive brake after an independent application, the automatic brake valve handle being in running position.

Q. Explain the flow of air through the independent brake valve when in *running position.* (Automatic brake valve handle in *running* position.)

A. Air from the application chamber of the distributing valve flows through the distributing valve release pipe and independent brake valve, then through the automatic brake valve to the atmosphere.

Q. When is *lap* position used?

A. When holding the engine and tender brake applied after an independent application.

Q. Is there any flow of air through the independent brake valve when in *lap* position?

A. No.

Q. When is *slow-application* position used?

A. When it is desired to apply the locomotive brakes lightly or gradually.

Q. Explain the flow of air through the independent brake valve when in *slow-application* position.

A. Air flows from the chamber above the rotary valve through the restricted service port and application cylinder pipe into the application cylinder and chamber of the distributing valve.

Q. When is *quick-application* position used?

A. When it is desired to apply the locomotive brakes promptly.

Q. Explain the flow of air through the independent brake valve when in *quick-application* position.

A. Air flows from above the rotary valve through a full open service port in the rotary valve and the application cylinder pipe to the application cylinder and chamber of the distributing valve.

Q. What prevents the independent brake valve handle from remaining in *release* position or in *quick-application* position unless held there?

A. A return spring.

Q. To what position does the return spring move the brake valve handle from *release* position?

A. To *running* position.

Q. Why is this necessary?

A. To prevent the possibility of the independent brake valve handle being left in *release* position, which

would cause the engine and tender brakes to release whenever an automatic application was made.

Q. To what position does the return spring move the brake valve handle from *quick-application* position?

A. To *slow-application* position.

Q. Why is the spring used for this purpose?

A. To act as a stop, guarding against a quick application when only a slow application is intended, and to return the handle from *quick* to *slow-application* position.

Q. Why is this latter necessary?

A. In order to limit the flow of air to the application cylinder when the independent brake is to be left applied.

NO. 6 DISTRIBUTING VALVE WITH PLAIN CYLINDER CAP.

Q. What controls the brake cylinder pressure on the locomotive with No. 6 ET equipment?

A. The distributing valve.

Q. How does it do this?

A. It permits air to flow from the main reservoirs to the brake cylinders when applying the brake, from the cylinders to the atmosphere when releasing the brake, and automatically maintains the pressure against leakage, keeping it constant, when holding the brake applied.

Q. Is the amount of air flowing from the main reservoirs to the brake cylinders limited by the distributing valve?

A. Yes; the distributing valve acts as a reducing valve in supplying air from the main reservoirs to the locomotive brake cylinders.

Q. Facing the distributing valve, name the two pipes on the right hand side of the reservoir and state to what each one connects.

A. (a) The upper pipe on the right is the brake cylinder pipe. It connects the distributing valve to all the brake cylinders on the engine and tender.

(b) The lower pipe on the right is the brake pipe branch pipe. It connects the distributing valve to the brake pipe.

Q. Name the three pipes on the left hand side of the reservoir and state to what each one connects.

A. (a) The upper pipe on the left is the supply pipe. It connects the distributing valve to the main reservoir pipe.

(b) The intermediate pipe is the application cylinder pipe. It connects the distributing valve to both the automatic and independent brake valves.

(c) The lower pipe is the release pipe, which connects the distributing valve to the independent brake valve and through it to the automatic brake valve.

Q. How many chambers has the distributing valve reservoir?

A. Two.

Q. Name them.

A. Pressure chamber and application chamber.

Q. How many pistons has the distributing valve?

A. Two.

Q. Name them.

A. Application piston 10 and equalizing piston 26.

Q. How many slide valves has the distributing valve?

A. Four.

Q. Name them.

A. Application valve 5, exhaust valve 16, equalizing valve 31 and graduating valve 28.

Q. What valves are operated by the application piston?

A. The application valve and the exhaust valve.

Q. What valves are operated by the equalizing piston?

A. The equalizing valve and graduating valve.

Q. With the brake released what pressures are present in the distributing valve?

A. Main reservoir pressure, brake pipe pressure and atmospheric pressure.

Q. In what portion of the distributing valve is main reservoir pressure?

A. In chamber *a*, (see Figure 2), above the application valve.

Q. In what portion of the distributing valve is brake pipe pressure?

A. In the pressure chamber and in the chamber above the equalizing valve and graduating valve.

Q. In what portion of the distributing valve is atmospheric pressure?

A. In chamber *b* above the exhaust valve 16 and on the right hand side of the application piston 10; in chamber *g* on the left hand side of the application piston (called the application cylinder) and in the application chamber and the ports and cavities connecting with them.

Q. How is chamber *a* charged with air at main reservoir pressure?

A. Through the branch pipe leading from the main reservoir pipe to the connection marked *MR* on the distributing valve reservoir.

Q. Describe the operation of the distributing valve

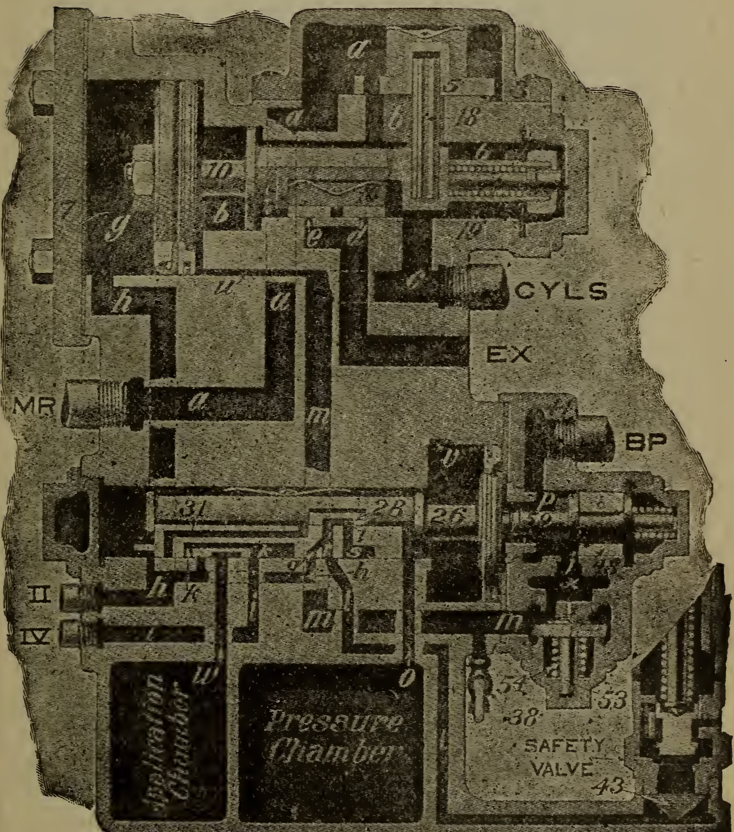


Fig. 3—Emergency Position of No. 6 Distributing Valve with Quick-Action Cap.

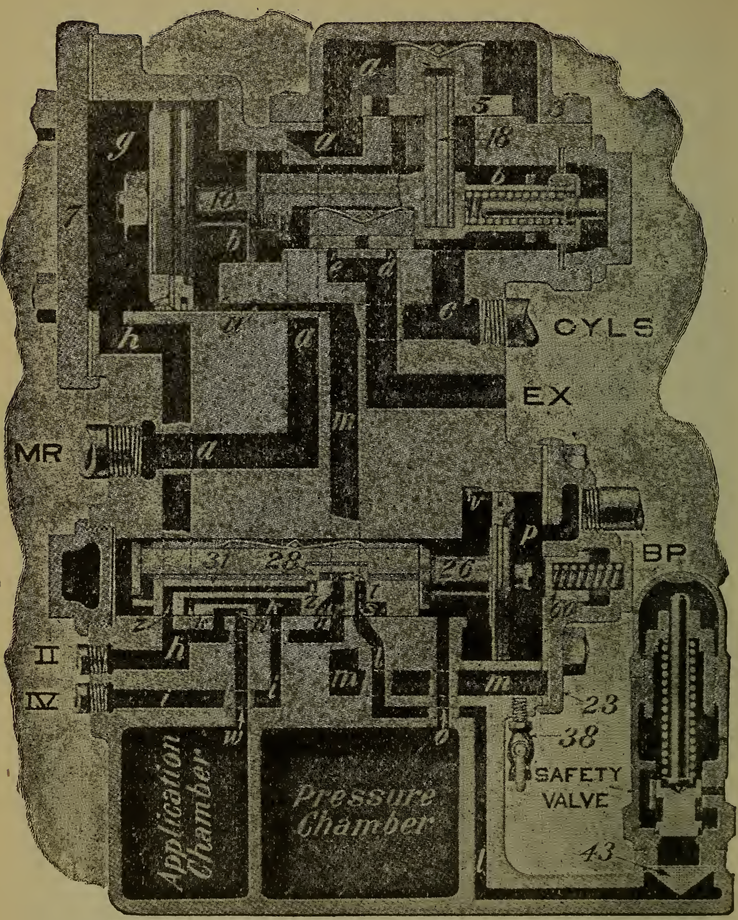


Fig. 4—No. 6 Distributing Valve Service Lap Position.

parts when an independent application of the brake is made.

A. Air is admitted to the application cylinder *g* and the application chamber from the reducing valve through the independent brake valve and the intermediate pipe on the left (application chamber pipe). This pressure will force the application piston 10 to the right (see Figure 3), lapping exhaust ports *d* and *e* with exhaust valve 16, and compressing graduating spring 19 and open supply port *b* through the application valve 5 to the brake cylinder chamber *b*, which is connected to the right of the application piston, obtaining a brake cylinder pressure slightly exceeding that in the application cylinder, when it and the graduating spring 19 then moves the piston 10 and the application valve 5 back to lap position (see Figure 3). The exhaust valve 16 will remain lapped, as there is sufficient clearance between the shoulders of the piston stem and the exhaust valve to permit the application valve to return to lap without moving the exhaust valve. At the same time cavity *s* in the equalizing valve 31 registers with ports *h* and *l* in the seat, thus connecting the application cylinder port *h* to the safety valve. *The equalizing piston and slide valve do not move during an independent application of the brake.*

Q. Describe the operation of the distributing valve parts when an independent release of the brake is made.

A. By a proper movement of the independent brake handle, air from the application cylinder *g*, and the application chamber is allowed to flow to the atmosphere, which reduces the pressure in chamber *g* below that in chamber *b*, causing the application piston 10 to move to the left, carrying with it application valve 5 and exhaust

valve 16 until ports *d* and *e* are open past and through exhaust valve 16 (See Figure 2), permitting the air in the brake cylinders to flow through port *e* into chamber *b*, thence through ports *d* and *e* to the exhaust and atmosphere. *The equalizing piston and its valves do not move during an independent release of the brakes.*

Q. How is the pressure chamber charged with air at brake pipe pressure?

A. Through the branch pipe leading from the brake pipe to the connection marked BP on the distributing valve reservoir (See Figure 2), leading into chamber *p* (See Figure 2), then through feed groove *v* around top of piston 26 into the chamber above the equalizing valve 31 and through port *o* to the pressure chamber until the pressures on both sides of the piston are equal.

Q. From where do the application cylinder and chamber receive their air?

A. From the *reducing valve* through the independent brake valve during independent applications, and from the *pressure chamber* during automatic service applications.

Q. Describe the operation of the distributing valve parts when an automatic service application of the brake is made.

A. The brake pipe pressure in chamber *p* on the brake pipe side of equalizing piston 26 being reduced below that in the pressure chamber on the opposite side of the piston results in piston 26 being moved toward the right. The first movement of piston 26 closes the feed groove *v*, and at the same time moves the graduating valve 28 until it opens the service port *z* in the equalizing valve, and connects safety valve ports *r* and *s* in equalizing

valve through cavity *t* in the graduating valve. As the piston continues its movement, the "spider" on the end of the piston stem engages the slide valve 31, which is then moved to the right until the supply port *z* in the equalizing valve registers with the application cylinder port *h* and through cavity *n* in the equalizing valve with application chamber port *w* in the seat. This permits the air in the pressure chamber to expand into the application cylinder. At the same time the safety valve is connected to the application cylinder and chamber by registering ports *r* and *s* in the equalizing valve with ports *h* and *l* in the seat and through the cavity *t* in the graduating valve, see Fig. 4. The amount of pressure obtained in the application cylinder and chamber depends upon the brake pipe reduction made. When the pressure in the pressure chamber is slightly reduced below that in the brake pipe, the piston and graduating valve are forced to the left until the collar on the piston stem comes in contact with the equalizing valve. This position is known as the "service lap," see Fig. 4. In this position the graduating valve has lapped port *z* between the pressure chamber and the application cylinder and has also lapped the safety valve port *l*. The air that expanded into the application cylinder and chamber will force the application piston 10 to the right, lapping the exhaust ports *d* and *e* with the exhaust valve 16, compressing graduating spring 19 and opening the supply port *b* through the application valve 5 to brake cylinder, as already explained.

Q. Describe the operation of the distributing valve when the brake is released with the independent brake valve, after an automatic application.

A. With the independent brake valve handle in *re-*

lease position, air in application cylinder *g,* and the application chamber flows direct to the atmosphere through the application cylinder pipe. This reduces the pressure in chamber *g* below that in chamber *b,* causing supply valve piston 10 to move to the left, carrying with it application valve 5 and exhaust valve 16 to *release* position, (see Fig. 2) thus releasing the brake.

Q. Do the equalizing parts of the distributing valve operate at this time?

A. No.

Q. Describe the operation of the distributing valve parts when making an automatic release of the brakes.

A. The brake pipe pressure in chamber *p* on the brake pipe side of equalizing piston 26 being increased above that in the pressure chamber on the opposite side of the piston results in the piston being moved toward the left, carrying with it graduating valve 28 and equalizing valve 31 to release position. In this position cavity *k* in equalizing valve 31 registers with ports *w, h* and *i* in the seat. This allows air from the application cylinder *g,* and the application chamber to flow through the ports mentioned to the distributing valve release pipe IV and to the atmosphere. At the same time the reduction of pressure in chamber *g* below that in chamber *b* causes the supply piston 10 to move to the left, carrying with it exhaust valve 16 to release position, (see Fig. 2) thus releasing the brake.

Q. Describe the operation of the distributing valve parts when an automatic emergency application of the brake is made.

A. Brake pipe pressure in chamber *p* on the brake pipe side of equalizing piston 26 is suddenly reduced

below that in the pressure chamber on the opposite side of the piston. The considerable difference in pressure thus created on the two sides of equalizing piston 26 is sufficient to move it to its extreme position to the right, compressing graduating spring 46, see Fig. 3. In this position port *h* is open directly to the chamber above equalizing valve 31, past the end of the valve, so that air from the pressure chamber flows through port "o," through the chamber above equalizing valve to port "h" and the application cylinder "*g*." The application port *w* is blanked by the equalizing valve 31 and the safety valve port *l* is connected through port *r* and restricted port *q* in valve 31 to port *h* of the application cylinder. The air that expanded into the application cylinder from the pressure chamber will force the application piston 10 to the right opening the application valve 5 as in service application and obtaining cylinder pressure equal to that in the application cylinder, when the application valve will lap.

Q. What brake cylinder pressure is obtained from a full automatic service application of the brake from a 70 pound brake pipe pressure? (Safety valve set at 68 pounds.)

A. Fifty pounds.

Q. What brake cylinder pressure is obtained with an automatic emergency application from a 70 pound brake pipe pressure? (Safety valve set at 68 pounds.)

A. About seventy pounds.

Q. How is the difference between service and emergency brake cylinder pressure obtained?

A. With all automatic service applications the pressure chamber is connected to both the application chamber and application cylinder, the relative volumes of

which are such that the air in the pressure chamber at 70 pounds pressure will equalize with the combined volumes of the application chamber and cylinder at 50 pounds pressure, which is, therefore, the maximum which can be obtained with an automatic service application. With all emergency applications the pressure chamber is not connected to the application chamber, but to the application cylinder only. The air in the pressure chamber then expands into the application cylinder, equalizing at about 65 pounds from a 70 pound brake pipe pressure. During emergency application air is admitted through a small port in the automatic brake valve (called the blow-down timing port) and the application cylinder pipe to the application cylinder. The size of the blow-down timing port in the brake valve is proportioned to the restricted port in the equalizing valve leading to the safety valve so as to give the proper time of blow-down of brake cylinder pressure.

Q. Will piston travel or brake cylinder leakage affect the brake cylinder pressure on the engine and tender?

A. No.

Q. How is a predetermined brake cylinder pressure obtained and maintained in the engine and tender brake regardless of piston travel and leakage?

A. As the brake cylinders receive their air from the main reservoirs they have practically an unlimited supply to draw from. The distributing valve and its reservoir volumes are constant, so that with a given brake pipe reduction, a given application cylinder pressure will be obtained (about 2½ pounds application cylinder and chamber pressure for every pound brake pipe reduction). The air that is admitted to the application cylinder forces the application piston and its valves to the right (see

Fig. 3), closing the exhaust ports and allowing air from the main reservoir branch pipe to flow to the brake cylinders until brake cylinder pressure becomes equal to that in the application cylinder, regardless of what the piston travel is, the number of cylinders, or the amount of leakage. When this pressure has been obtained, if brake cylinder leakage exists, the drop in cylinder pressure will reduce the pressure in chamber *b* on the right of piston 10 below that in application cylinder *g* on the opposite side of the piston. This will cause application piston 10 to again move to the right, opening application valve 5 and allowing air to flow from the main reservoirs to the brake cylinders until the brake cylinder pressure again equalizes with that in the application cylinder, when the application piston 10 and supply valve 5 will move to lap position (see Fig. 4). This action will continue indefinitely until the brakes are released.

SAFETY VALVE.

Q. What is the purpose of the safety valve? See Figures 2 and 4.

A. To prevent abnormal brake cylinder pressure and to act as a high speed reducing valve for the locomotive brake cylinders.

Q. To what is the safety valve connected?

A. To the application cylinder.

Q. When is the safety valve connected to the application cylinder?

A. At all times except in automatic service lap position of the distributing valve.

Q. For what pressure is the safety valve adjusted?

A. Sixty-eight pounds, except when the locomotive is

transported light over the road, when it is ordinarily adjusted to 35 pounds.

Q. How does the safety valve act as a high speed reducing valve?

A. When an automatic service application is made and the equalizing valve and graduating valve are in service positions, the safety valve is connected to the application cylinder and chamber through large ports, and will therefore prevent the brake cylinder pressure rising above that for which the safety valve is adjusted. During emergency application the connection between the application cylinder and the safety valve is smaller than during service application, so that the flow of air frcm the application cylinder to the safety valve is restricted, which, in conjunction with the blow-down timing port, regulates the time of blow-down of brake cylinder pressure.

QUICK-ACTION CYLINDER CAP.

Q. Where is the quick-action cylinder cap located?

A. On the brake pipe end of the distributing valve where it replaces the plain cylinder cap 23, see Fig. 2.

Q. What is its purpose?

A. To vent brake pipe air into the locomotive brake cylinders when an emergency position of the brake is made.

Q. Does it operate at any other time?

A. No.

Q. Why is this cap used?

A. To assist in obtaining an emergency application of the brakes in the train when double heading.

Q. Then the quick-action cylinder cap performs the

same function in actuating quick-action as a quick-action triple valve on the tender with other types of locomotive brakes?

A. Yes.

Q. Does the air flowing to the brake cylinders through the quick-action cylinder cap increase the brake cylinder pressure, as is the case with the quick-action triple valve?

A. No; as the brake cylinder presssure is governed by the pressure in the application cylinder of the distributing valve.

Q. What advantage has this device over quick-action triple valves on the tender?

A. It is less liable to cause undesired quick-action than a triple valve, as it is much less sensitive.

Q. Why is it possible to use a valve less sensitive to quick-action than a triple valve?

A. As the quick-action cylinder cap is always located close to the automatic brake valve being operated; when an emergency application is made the quick-action cylinder cap is subjected to a more rapid brake pipe reduction than is the case with a triple valve located at a considerable distance from the brake valve, and consequently need not be so sensitive in order to accomplish its purpose.

Q. When the distributing valve is provided with a quick-action cap, how should the automatic brake valve handle be operated?

A. Exactly the same as when the distributing valve has plain cylinder cap.

Q. Describe the operation of the quick-action cylinder cap.

A. When the automatic brake valve handle is moved to emergency position, equalizing piston 26 (see Fig-

ure 3, moves to the right, which movement causes the knob on the piston to strike the graduating stem 59, causing it to compress graduating spring 60, moving emergency valve 48 so as to open port *j*. Brake pipe pressure in chamber *p* then flows to chamber X, unseats check valve 53 and passes to the brake cylinders through port *m* in the cap and distributing valve body.

Q. What duty does the check valve 53 perform?

A. When the brake cylinder and brake pipe pressures become equal, the check valve is forced to its seat by spring 54, thus preventing air in the brake cylinders from flowing back into the brake pipe.

Q. What takes place when a release is made?

A. Piston 26 is moved back to *release* position, spring 60 forces graduating stem 59 and emergency valve 48 back to the position shown in Figure 2.

Q. Are there any other differences in the operation of the distributing valve having this cap?

A. No; in all other respects the operation of the distributing valve is the same as described under the heading "No. 6 Distributing Valve With Plain Cylinder Cap."

THE B-6 FEED VALVE.

Q. How does the B-6 feed valve differ from that used with former automatic brake equipments?

A. The B-6 feed valve is made adjustable for either high or low brake pipe pressure and can easily be changed from one to the other. Otherwise, except for improvements in the mechanical design of the valve, it is the same as that used with former equipments.

Q. How is the change in adjustment accomplished?

A. The adjusting nut is provided with a hand wheel,

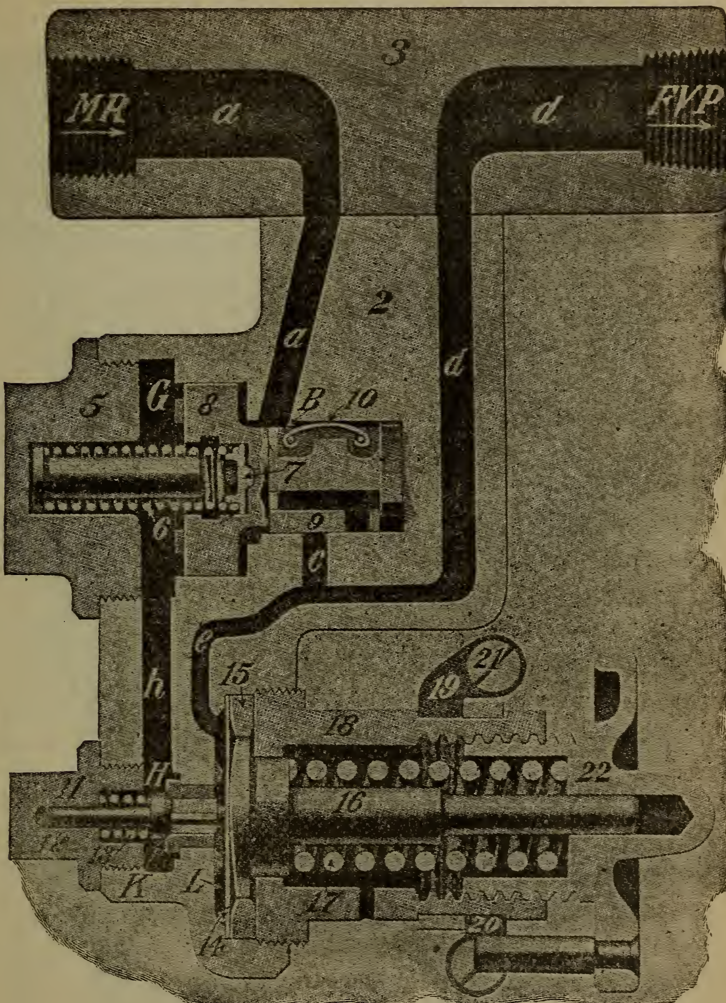


Fig. 5—Diagram of B-6 Feed Valve Closed.

CONNECTIONS:

MR—Main-Reservoir Pipe; **FVP**—Feed-Valve Pipe.

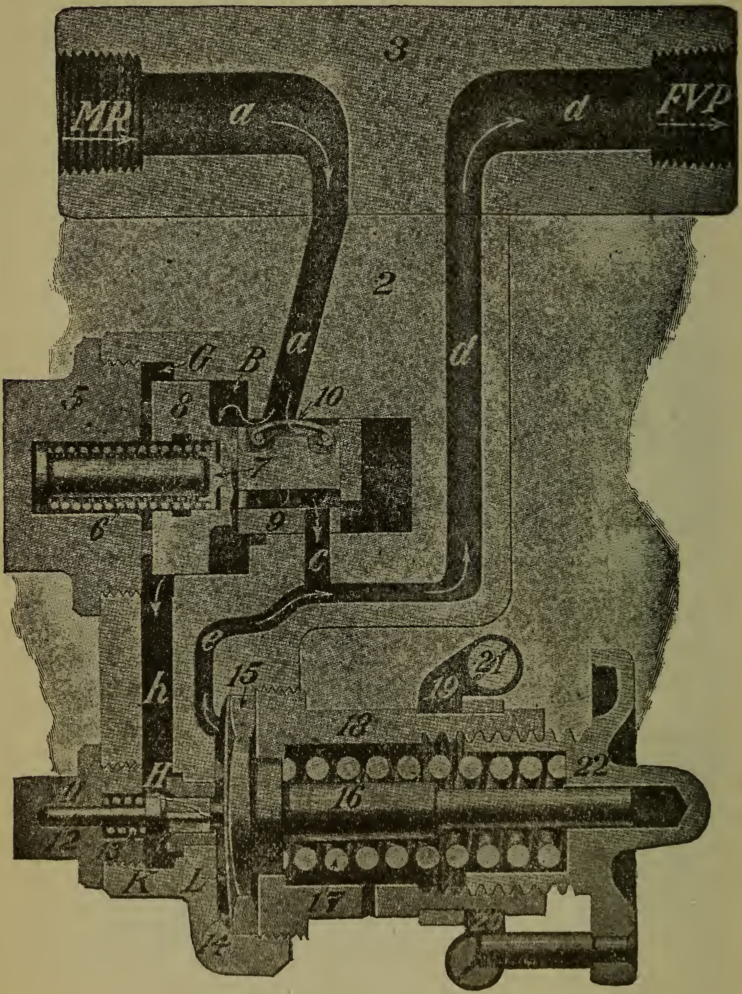


Fig. 6—Diagram of B-6 Feed Valve Open.
(For connections see Fig. 5.)

having a lug, working between two adjustable stops on the body of the valve. These stops are adjusted for the high and low brake pipe pressure which it is desired to carry and the change of pressure from one to the other is accomplished by simply turning the hand wheel from one stop to the other.

Q. Where is the feed valve located?

A. On a bracket interposed between the main reservoir and feed valve pipes.

Q. Why is this bracket used?

A. To support the valve and permit it to be easily removed and replaced.

Q. What are the essential working parts of the feed valve?

A. The supply valve and actuating piston, the regulating valve, diaphragm, regulating spring and supply valve piston spring.

Q. Explain the general arrangement of the feed valve?

A. The feed valve consists of two sets of parts designated as the supply parts and the regulating parts. The supply parts, which control the flow of air through the valve consist of the supply valve 9 (see Figure 5), and its spring 10, supply valve piston 8 and supply valve piston spring 6. The regulating parts consist of the regulating valve 12, regulating valve spring 13, diaphragm 14, diaphragm spindle 16 and regulating spring 17.

Q. What is the normal position of this valve?

A. Closed, as shown in Figure 5.

Q. Explain the duty of the various operative parts.

A. Supply valve 9 is for the purpose of opening and closing port *c* in its seat. Piston 8 is for the purpose of

moving the supply valve 9. Spring 6 is for the purpose of moving the piston and closing the supply valve when the pressures have equalized on both sides of piston 8.

Q. What are the duties of the regulating parts?

A. To control the action of the supply valve piston and supply valve when opening and closing the supply port *c* in the seat.

Q. Explain the operation and flow of air through the feed valve when open.

A. By referring to Figure 5, which is a diagrammatic view of the valve in its closed position, air entering through port *a* from the main reservoir is free to pass into the supply valve chamber "B" causing the supply valve piston 8 to be moved to the left, compressing piston spring 6, as shown in Figure 6, by which movement the supply valve 5 uncovers port *c* in the valve seat, thereby permitting air to pass directly through ports *c* and *dd* to the feed valve pipe at the same time air is passing by the supply valve piston 8, which is not an airtight fit, to chamber *G*, thence through port *hH* by the regulating valve 12, and through port *K* to diaphragm chamber *L* and on through ports *edd* to the feed valve pipe.

Q. What will cause a valve to close and stop the flow of air from the main reservoir to feed valve pipe?

A. When the pressure in the feed valve pipe and chamber L slightly exceeds the tension of the regulating spring 17, the diaphragm 14 will yield and allow regulating valve 12 to move to its seat, closing port *K*, and preventing the flow of air from chamber *G*. As the air continues to leak by supply valve piston 8, it will equalize the pressure on both sides of the piston and allow supply valve piston spring 6, which was previously compressed,

to react and move the piston and supply valve to the position shown in Figure 5, closing port *c* in the supply valve seat.

Q. With the feed valve closed, and the pressure equalized on each side of the supply valve piston, what will cause it to open to supply the feed valve pipe when the pressure has been reduced?

A. Diaphragm chamber *L* is always in direct communication with the feed valve pipe; therefore, any reduction in feed valve pipe pressure reduces the pressure in chamber *L*, which allows the tension of the regulating spring to overcome the diminished air pressure in chamber *L*, and force the diaphragm 14 to the left. This unseats the regulating valve 12, permitting the accumulated air pressure in chamber *G* to escape to the feed valve pipe through ports *hH* and through port *K*, diaphragm chamber *L* and ports *edd*. The equilibrium of pressure on the two sides of the supply valve piston now being destroyed, the main reservoir pressure which is present in supply valve chamber *B* forces the supply valve piston 8 to the left, which moves the supply valve 9 with it, opening port *c* and again permitting the air to pass to the feed valve pipe until the pressure has been restored to the proper amount.

Q. The supply valve then maintains practically a wide open port until maximum pressure is obtained?

A. Yes; and when maximum pressure is obtained, the supply valve closes the supply port quickly.

C-6 REDUCING VALVE.

Q. What is the difference in the construction and operation of the C-6 reducing valve and the B-6 feed valve?

A. The only difference between it and the B-6 feed valve just described is in the convenience of adjustment, the C-6 reducing valve having the ordinary adjusting nut and cap nut used on former types of feed valves instead of the hand adjusting wheel 22 used with the B-6 feed valve shown in Figure 6. It is called a "Reducing Valve" simply to distinguish it from the B-6 feed valve.

SF-4 PUMP GOVERNOR.

Q. Where is the SF-4 pump governor located?

A. In the pipe supplying steam to the air compressor.

Q. Explain the general arrangement of the pump governor.

A. It consists of a standard steam portion, with Siamese fitting, and two diaphragm portions, as illustrated in Figure 7.

Q. How are these diaphragm portions designated?

A. That having two pipe connections the *excess pressure head* and that having a single pipe connection the *maximum pressure head.*

Q. What are the pipe connections of the governor?

A. *B*, to the boiler; *P*, the air compressor; *MR*, main reservoir; *AB*, the automatic brake valve; *FVP*, the feed valve pipe; *W*, waste pipe.

Q. When does the excess pressure head govern the operation of the air compressor?

A. At all times when the automatic brake valve handle is in *release, running* or *holding* positions.

Q. When does the maximum pressure head govern the operation of the air compressor?

A. During the time the automatic brake valve handle is in *lap, service,* or *emergency* positions.

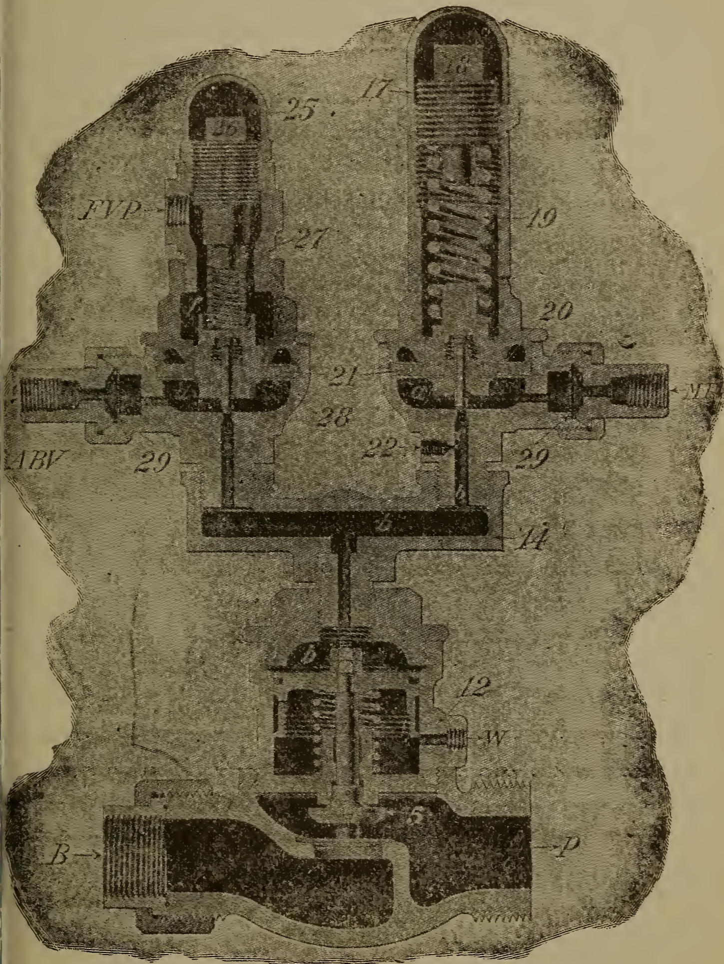


Fig. 7—The SF-4 Pump Governor.

Q. Explain the flow of steam through the governor.

A. Steam enters at *B*, passes by steam valve 5 to the connection *P*, and on to the air compressor.

Q. With the automatic brake valve handle in *release*, *runinng* or *holding* position, what pressures act on the diaphragm 28 of the excess pressure head?

A. Air from the main reservoir flows through the automatic brake valve to the connection marked *ABV*, to chamber *d* under diaphragm 28. Air from the feed valve pipe enters at connection *FVP* and flows to chamber *f* above diaphragm 28. In addition to this, regulating spring 27 also acts upon the upper side of the diaphragm.

Q. What is the adjustment of this spring?

A. About 20 pounds.

Q. What total pressure is, therefore, acting upon the upper side of diaphragm 28?

A. Whatever pressure the feed valve pipe may have, plus the tension of the regulating spring 27.

Q. What pressure in chamber *d* below diaphragm 28 will be required to overcome that acting on the upper side of the diaphragm?

A. A pressure slightly higher than that in the feed valve pipe plus the spring pressure. For example, with a pressure of 70 pounds in the feed valve pipe, about 90 pounds pressure below diaphragm 28 will be required to overcome that acting upon the upper side of the diaphragm.

Q. How does a variation in feed valve adjustment affect the governor?

A. When the feed valve adjustment is changed from one amount to another as where the locomotive is used alternately in high speed brake and ordinary service, the excess pressure head of the governor automatically

changes the main reservoir pressure so as to maintain the same excess pressure (20 pounds).

Q. Why is this of advantage?

A. Because it insures that the main reservoir pressure will always be 20 pounds higher than that of the feed valve pipe.

Q. Explain the operation of the governor when main reservoir pressure in chamber *d* below diaphragm 28 becomes slightly higher than that acting on top of the diaphragm.

A. Diaphragm 28 will rise, unseat its pin valve 33, and allow air to flow to chamber *b* above the governor piston 6, forcing the latter down, compressing piston spring 9 and restricting the flow of steam past steam valve 5 to a point where the compressor will just supply the leakage in brake system.

Q. How long will the flow of steam through the governor be restricted in this manner?

A. Until main reservoir pressure in diaphragm chamber *d* becomes reduced slightly below the combined spring and air pressure in chamber *f* above the diaphragm, which will then force diaphragm down, seating its pin valve.

Q. How does this effect the flow of steam through the governor?

A. As chamber *b* is always open to the atmosphere through the small vent port *c*, the air pressure in chamber *b* above the governor piston 6 will then escape to the atmosphere and allow piston spring 9, and the steam pressure below valve 5 to raise it, and the governor piston 6 to the position shown. See Figure 7.

Q. With the automatic brake valve handle in *release*, *running* or *holding* position, does the maximum pressure head operate?

A. No; as during this time its diaphragm pin valve remains seated.

Q. To what is chamber *a* in the maximum pressure head always connected?

A. To the main reservoir.

Q. When does the maximum pressure head of the governor control the operation of the compressor?

A. When the automatic brake valve handle is in *lap*, *service* or *emergency* position, or when the main reservoir cut-out cock is closed.

Q. With the automatic brake valve handle in *lap*, *service* or *emergency* position, or when the main reservoir cut-out cock is closed, what pressures act on the diaphragm 20 of the maximum pressure head?

A. Main reservoir pressure which flows directly to chamber *a* on the underside of diaphragm 20 and the pressure of regulating spring 19 on the upper side.

Q. What is the adjustment of spring 19?

A. Spring 19 is adjusted to the maximum pressure which is desired in the main reservoirs.

Q. Explain the operation of the governor when main reservoir pressure in chamber "a" exceeds the tension of spring 19.

A. When main reservoir pressure in chamber *a* slightly exceeds the adjustment of spring 19, diaphragm 20 will rise, unseat its pin valve 33, and allow air to flow into chamber *b* above the governor piston, forcing it down, compressing its spring 9 and restricting the flow of steam past steam valve 5 to a point where the compressor will just supply the leakage in brake system.

Q. How long will the flow of steam through the governor be restricted in this manner?

A. When main reservoir pressure in chamber *a* be-

comes slightly reduced, the spring 19 forces diaphragm 20 down, seating its pin valve. As chamber *b* is always open to the atmosphere through the small vent port *c*, the pressure in chamber *b* above the governor piston 6 will then escape to the atmosphere and allow the piston spring 9 and steam pressure below valve 5 to raise the valve and governor piston to the position shown. See Figure 7.

Q. Is the maximum pressure head of the governor in any way controlled by the automatic brake valve?

A. No; as the chamber *a* below the diaphragm is in no way connected to the brake valve.

Q. With the automatic brake valve handle in *lap*, *service* or *emergency* positions or when the main reservoir cut-out cock is closed why does not the excess pressure head operate instead of the maximum pressure head?

A. Because under these conditions, communication from the main reservoir to chamber *d* is cut off by the brake valve and at the same time connection from the feed valve pipe to chamber *f* above diaphragm 28 still remains open, so that the combined air and spring pressure on top of the diaphragm holds the pin valve to its seat, rendering the excess pressure head inoperative.

Q. Under ordinary running conditions, why is only a moderate excess pressure desirable?

A. Because most of the time the automatic brake valve handle is in *running* position, (keeping the brakes charged) but little excess pressure is needed and the governor regulates the main reservoir pressure to about 20 pounds above the brake pipe pressure, thus relieving the compressor of unnecessary work.

Q. When an application of the brakes is made, why is the higher excess pressure of advantage?

A. To insure a prompt release of the brakes and recharge of the system.

DEAD ENGINE FIXTURES.

Q. What are the parts composing the dead engine fixtures?

A. A ⅜-inch pipe connecting the brake pipe and main reservoir pipe, a combined strainer and check valve with choke fitting, and a ⅜-inch cut-out cock.

Q. What is the purpose of the "Dead Engine" feature of the ET Equipment?

A. To enable the compressor on a "live" engine to charge the main reservoir on a "dead" engine, so that the brake on the dead engine may be operated with the other brakes in the train.

Q. How is this done?

A. Air from the main reservoir of the live engine passes through the brake pipe and dead engine fixtures to the main reservoirs of the dead engine.

Q. When is this apparatus used?

A. Only when the air compressor on the locomotive is inoperative.

Q. Should the cut-out cock always be closed except when the compressor is inoperative?

A. Yes.

Q. Describe the flow of air through the combined strainer and check valve.

A. With the cut-out open, air from the brake pipe enters at *BP*, passes through the curled hair strainer, lifts the check valve, held to its seat by a strong spring, passes through the choke bushing, and out at *MR* to the main reservoir pipe.

Q. Why is a spring used in this valve?

A. This spring over the check valve insures the valve seating and keeps the main reservoir pressure somewhat lower than the brake pipe pressure, yet assures ample pressure to operate the locomotive brakes.

Q. What is the object of the choke fitting?

A. It prevents a sudden drop in brake pipe pressure and the application of the brakes in the train, as might otherwise occur with uncharged main reservoirs cut into a charged brake pipe or if for any reason the main reservoir pressure was lower than the brake pipe pressure.

Q. How can the maximum brake cylinder pressure be regulated on a dead engine?

A. By the adjustment of the safety valve on the distributing valve.

Q. Can the brake on a dead engine be controlled with the independent brake valve the same as on a live engine?

A. Yes, if it becomes necessary.

Q. When the dead-engine feature is used, in what position should the automatic and independent brake valve handles be carried?

A. *Running* position.

Q. What should be the position of the double heading cock?

A. Closed.

Q. Is it sometimes desirable to keep the braking power of a locomotive below the standard?

A. Yes; when there is no water in the boiler.

Q. How is this done?

A. By adjusting the safety valve on the distributing valve to the maximum brake cylinder pressure which is desired in the locomotive brake cylinders.

AIR GAGES.

Q. How many and what type of gages are used in connection with the ET Equipment?

A. Two duplex gages, designated—No. 1, Large Duplex Air Gage; No. 2, Small Duplex Air Gage.

Q. What pressures are indicated by gage No. 1?

A. Red Hand, Main Reservoir Pressure; Black Hand, Equalizing Reservoir Pressure.

Q. What pressures are indicated by gage No. 2?

A. Red Hand, Brake Cylinder Pressure; Black Hand, Brake Pipe Pressure.

Q. Which gage hand shows the amount of reduction being made during a service application of the brakes?

A. Black Hand, Gage No. 1.

Q. Why, then, is the black hand of gage No. 2 necessary?

A. To show brake pipe pressure when engine is second in double-heading or a helper.

Q. What pressure is indicated by the red hand of gage No. 2 when operating the automatic or independent brake valve?

A. Brake cylinder pressure.

CUT-OUT COCKS.

Q. What provision is made for cutting off the main reservoir from the brake system?

A. The main reservoir cut-out cock in the main reservoir pipe.

Q. What takes place when this cock is closed?

A. The flow of air from the main reservoir is cut off and the air in the brake system back of it is exhausted to the atmosphere.

Q. When this cock is closed can air flow from the main reservoir to any part of the system?

A. Yes; to the maximum pressure head of the pump governor.

Q. Why is this necessary?

A. To provide for the automatic control of the compressor when the cut-out cock is temporarily closed.

Q. What provision is made for cutting out the driver brake?

A. A ¾-inch cut-out cock located in the pipe leading from the distributing valve to the driver brake cylinders.

Q. What provision is made for cutting out the tender brake?

A. A ¾-inch cut-out cock located in the pipe between the distributing valve and the hose connection leading to the tender brake cylinder.

Q. What difference is there between this cock and the ¾-inch cocks generally used?

A. It has a choke fitting.

Q. Why is this choke fitting used?

A. To prevent a loss of driver and truck brake cylinder pressure in the event of a hose or tender brake cylinder pipe bursting.

Q. Is there another cock with choke fitting sometimes used in connection with this apparatus?

A. Yes; when a truck brake is used a ½-inch cock is located in the pipe leading from the distributing valve to the truck brake cylinder with choke fitting.

Q. For what purpose is the ¾-inch cut-out cock in the main reservoir supply pipe to the distributing valve?

A. To cut off the supply of air from the main reservoirs to the distributing valve to permit of inspection and repairs.

Q. For what purpose is the one-inch double heading cock underneath the brake valve?

A. To cut off the flow from the automatic brake valve to the brake pipe, or vice versa.

Q. What is the purpose of the brake pipe air strainer?

A. To prevent foreign matter entering the distributing valve, which might seriously interfere with its proper operation.

AIR SIGNAL SYSTEM.

Q. From what source is the supply of air to the signal system obtained with the ET Equipment?

A. From the reducing valve pipe between the reducing valve and the independent brake valve, as shown in Instruction Diagram, page 122.

Q. Why is this supply taken from the reducing valve pipe?

A. That the one reducing valve may govern the pressure for both the independent brake valve and the signal system.

Q. What device is interposed between the reducing valve pipe and the air signal pipe?

A. A combined strainer and check valve.

Q. Why is the strainer necessary?

A. To protect the check valve and signal system from foreign matter.

Q. Why is the check valve employed?

A. To prevent a back flow of air from the signal pipe to the reducing valve pipe.

Q. In what way does this combined strainer and check valve differ from that used with the dead engine fixtures?

A. Only in the tension of the check valve spring.

GENERAL OPERATION OF THE NO. 6 EQUIPMENT

NOTE.—Details of construction and operation of the various devices will be found under their respective headings.

Q. What is the proper position of the brake valve handles and cut-out cocks before starting the compressor?

A. The automatic and independent brake valve handles in *running* position all cut-out cocks must be open, except the ⅜-inch cut-out cock in the dead engine connection and the angle and stop cocks at the front, and rear end of the locomotive.

Q. Explain the charging of the ET Equipment.

A. While the compresssor is operating, the main reservoir pressure continues to rise until it reaches the point for which the governor is adjusted. The governor then automatically stops the compressor. From the main reservoirs air flows through the main reservoir pipe to the chamber above the application valve of the distributing valve. It also flows to the feed valve which reduces the pressure of the air to that carried in the brake pipe. The air at this reduced pressure flows through the automatic brake valve to the brake pipe and thence through the branch pipe and distributing valve to the pressure chamber charging it up to brake pipe pressure. Air also flows from the main reservoirs through the reducing valve to the independent brake valve and air signal system.

Q. What must be done to make an automatic service application of the brake?

A. Move the automatic brake valve handle to *service* position.

Q. How does this apply the brake?

A. It starts a reduction of brake pipe pressure which causes the distributing valve to operate so as to allow air to flow from the main reservoirs into the brake cylinders.

Q. How is the application of the brake limited to any desired cylinder pressure?

A. By returning the automatic brake valve handle to *lap* position.

Q. What must be done to make an emergency application of the brakes?

A. Move the automatic brake valve handle to *emergency* position.

Q. How does an emergency application of the brake differ from a service application?

A. Brake pipe reduction takes place more rapidly, brake cylinder pressure rises more quickly and a higher brake cylinder pressure is obtained than in service applications.

Q. In what position should the automatic brake valve handle be placed to release the locomotive brake?

A. *Running* position.

Q. Is there any position besides *running* position in which the locomotive brake can be released by the use of the automatic brake valve?

A. No.

Q. Can the locomotive brake be applied otherwise than by using the automatic brake valve?

A. Yes. By the independent brake valve.

Q. In what position should the independent brake valve handle be placed to apply the locomotive brakes?

A. *Application* position.

Q. How does this apply the brake?

A. It allows air to flow from the reducing valve through the independent brake valve to the distributing valve, causing it to operate, and allow air to flow from the main reservoirs into the brake cylinders at a reduced pressure.

Q. Is the operation of the train brakes affected in any way by the independent application of the locomotive brakes?

A. No.

Q. How is the independent application of the locomotive brake limited to any desired cylinder presssure?

A. By returning the independent brake valve handle to *lap* position.

Q. How can the locomotive brake be released by the independent brake valve?

A. (a) If the automatic brake valve handle is in *running* position, move the independent brake valve handle to *running* position.

(b) If the automatic brake handle is *not* in *running* position, the independent brake valve handle must be moved to *release* position.

Q. Can the locomotive brake be released without in any way interfering with the train brakes under any and all conditions?

A. Yes; by placing the independent brake valve handle in *release* position.

TESTING AND OPERATING THE ET EQUIPMENT. TESTING LOCOMOTIVE BRAKE.

Q. Preparatory to making a test of the brake what should be done?

A. Blow out the brake pipe and signal pipe by open-

ing and closing quickly a number of times the angle and stop cocks, both at the pilot and rear of the tender.

Q. Why is this done?

A. To remove scale and other foreign matter that may be in the brake and signal pipes.

Q. What observations should the engineer make before taking the engine to the train?

A. He should observe by the gages that the proper pressures are present in different parts of the system. This will show that the regulating devices (governors, feed valves, etc.) are properly adjusted. He should also observe that the brake is in proper condition generally.

Q. What test should then be made?

A. The brake should be applied and released with both the automatic and independent brake valves, to determine if the brake is in proper operative condition.

MANIPULATION OF LOCOMOTIVE AND TRAIN BRAKES.

Q. What is the proper position of the automatic and independent brake handles when not being operated?

A. *Running* position.

Q. After attaching the engine to the train in what position should the automatic brake valve be carried while charging the train brakes?

A. *Release* position.

Q. How long should the brake valve handle be left in this position?

A. Until the brake pipe system is charged to the pressure to be carried.

Q. How should the automatic brake valve be handled when testing the brakes.

A. A full service application of the brakes should be

made and the handle then moved to *lap* position.

Q. How should the brakes be released?

A. Place the brake valve handle in *release* position for the proper length of time, then return it to *running* position, leaving it there.

Q. If the brakes apply in emergency from an unknown cause, while train is running, what should be done?

A. Move automatic brake valve handle quickly to *emergency* position and leave it there until train stops.

Q. Why is this done?

A. To insure the brakes remaining applied and to prevent loss of main reservoir pressure.

Q. What must be done in the event of sudden danger?

A. Move the automatic brake valve handle quickly to *emergency* position and leave it there until the train stops and the danger is past.

Q. With brakes applied in emergency, would anything be gained by moving the independent brake valve handle to *application* position?

A. No. Because in an application of this kind the application cylinder pressure is higher than the maximum pressure obtainable with the independent brake.

Q. If, in making a stop, the driving wheels slide, can they be released?

A. Yes; by placing the independent brake valve handle in *release* position and holding it there until the wheels again revolve, reapplying the brakes, if desired, with this brake valve.

Q. In the event of releasing and reapplying the locomotive brake in this manner, in what position should the independent brake valve handle be left after the application is made?

A. *Running* position.

Q. Why?

A. Because if left in any other position the locomotive brake cannot be released by the automatic brake valve.

Q. Does the releasing and reapplying of the engine and tender brakes with the independent brake valve in this way have any effect on the train brakes?

A. No; as the operation of the independent brake valve does not interfere with the train brakes.

Q. In making a service application, how should the automatic brake valve be handled?

A. The same as with the older type of brake valves.

Q. In making the first release of a two-application stop, how should the brake valve be handled?

A. (a) With short passenger trains release the brakes by moving the brake valve handle to *running* position a sufficient length of time to start the locomotive and train brakes releasing, then to *lap* position.

(b) With the long passenger trains the brake valve handle should be moved to *release* position for about three seconds to start the train brakes releasing, then to *running* position to partly release the locomotive brake, then to *lap*.

Q. In making the final release of a two-application stop, how should the automatic brake valve be handled?

A. (a) With short passenger trains, release the brakes just before coming to a stop by moving the brake valve handle to *running* position and leaving it there.

(b) With long passenger trains, the brakes should be held applied until the train stops.

Q. In making a release after a one-application stop, how should the brake valve be handled?

A. The same as a final release of a two-application stop, as just explained.

Q. Why is it necessary to move the automatic brake valve handle promptly to *running* position after going to *release* in releasing the brakes?

A. Because with the brake valve in *release* position, the locomotive brake is held applied.

Q. What is the only position of the automatic brake valve which will permit the release of both the locomotive and train brakes together?

A. *Running* position.

Q. Is there any other position besides *running* position which will release train brakes?

A. Yes; *release* position and *holding* position.

Q. Is there any other than running position in which the locomotive brake can be released by the automatic brake valve?

A. No.

Q. Can the locomotive brake always be released by placing the automatic brake valve handle in *running* position?

A. No.

Q. Why?

A. Because if the independent brake valve handle is not in *running* position, the locomotive brake cannot be released by the automatic brake valve.

Q. If the driving wheels pick up and slide while making a stop, what should be done?

A. Release with the independent brake valve.

Q. In handling a light locomotive, which brake valve should be used?

A. The independent brake valve.

Q. For a gradual application of the locomotive brake, how should the independent brake valve be used?

A. Place the brake valve handle in *slow-application* position until the brake is sufficiently applied; then return it to *lap* position.

Q. How operated if a quick application of the locomotive brake is desired?

A. Place the independent brake handle in quick-application position until the brake is sufficiently applied, then return it to *lap* position.

Q. Should the independent brake valve be used in completing a train stop?

A. No.

Q. Why?

A. Because to apply the locomotive brake with the train brakes released will cause slack to run in and produce shocks.

Q. In case of emergency, should the independent brake valve be used on a light locomotive?

A. No; in *all* cases of emergency, move the *automatic* brake valve handle to *emergency* position.

Q. Why?

A. Because a considerably higher brake cylinder pressure is obtained than would be possible with the use of the independent brake valve.

Q. How can the locomotive brake always be released regardless of the position either brake handle may be in?

A. By placing the independent brake valve handle in *release* position.

Q. How can the locomotive brake be held applied while releasing the train brakes?

A. By moving the automatic brake valve handle to either *release* or *holding* positions.

Q. Can this be done in any other way?

A. Yes; by placing the independent brake valve handle in *lap* position.

Q. Why should not the independent brake valve be used for this purpose?

A. First—Because it is better to use the automatic brake valve alone instead of in conjunction with the independent brake valve. Second—Because if the independent brake valve is used for this purpose, it may be left in *lap* position by mistake and the proper operation of the brakes by the automatic brake valve interfered with.

Q. Why should the automatic brake valve handle never be left in *lap* position except while bringing the train to a stop?

A. Because if the handle is left in *lap* position when the brakes are not applied, brake pipe leakage may materially reduce the brake pipe and auxiliary rescrvoir pressures, so that full braking power cannot be obtained and because the driver brakes are likely to apply as the outlet from the application chamber is closed.

Q. If, after a brake application, the automatic brake valve handle is moved to *release* position and returned to *lap* position, what will be the result?

A. The locomotive brake will remain applied.

Q. What is the advantage of having the locomotive brake remain applied under these conditions?

A. It would serve as a warning in case of neglect to move the handle to the proper position.

Q. Would anything be gained by moving the automatic brake valve handle to *release* position for a short time just before making an application of the brakes?

A. No; this should never be done.

Q. Why?

A. Because by placing the automatic brake valve handle in *release* position the brake pipe will be charged higher than the pressure in the auxiliary reservoirs; consequently, the brakes cannot be applied until after this difference in pressure has been drawn off.

FREIGHT BRAKING.

Q. What feature of the No. 6 ET Equipment is of particular advantage in handling trains on long, descending grades?

A. The ability to handle the locomotive brake with, or entirely independent of the train brakes.

Q. What is gained by this?

A. The locomotive and train brakes can be alternated without interfering with each other.

Q. With all the brakes applied, can the locomotive brake be released without releasing the train brakes?

A. Yes.

Q. How can this be done?

A. By placing the handle of the independent brake valve in *release* position, holding it there until the brake is released.

Q. After releasing in this manner, where should the handle of the independent brake valve be placed?

A. *Running* position.

Q. If it is then desired to release the train brakes and recharge the reservoirs, and reapply the locomotive brakes, in order to assist the retaining valves, in holding the train, how can this be accomplished?

A. Place the independent brake valve handle in *application* position until the desired locomotive brake cylinder

pressure is obtained, then return it to *running* position, then move the automatic brake valve handle to *release* position and leave it there until the train is charged.

Q. What is the maximum pressure obtainable in the brake pipe under these conditions?

A. As the excess pressure head of the duplex governor will be in control, the maximum pressure obtainable will be twenty pounds above that ordinarily carried in the brake pipe.

Q. When reapplying the train brakes, how can excessive locomotive brake cylinder pressure be prevented?

A. By partially releasing the locomotive brake with the independent brake valve before reapplying the train brakes.

Q. How can the overheating of the driving wheel tires be prevented?

A. By either holding the independent brake valve handle in *release* position when making an automatic application or by releasing immediately with the independent brake valve after the automatic application.

Q. When releasing the brakes on a freight train when in motion should the automatic brake valve be handled in the same manner as with passenger trains?

A. No; the brake valve handle should be moved to *release* position and allowed to remain there for a period of time, according to the length of the train, but not to exceed twenty seconds.

Q. Why should this be done?

A. To insure a proper release of the train brakes and hold the locomotive brake applied, thus preventing the slack of the train running out.

Q. In making releases on long trains, after the brake valve handle has been returned to *running* position, should

it again be moved to *release* position for an instant?

A. Yes; after being in *running* position for about three seconds.

Q. Why?

A. Because in making such a release some of the head brakes may have been overcharged and may reapply.

BROKEN PIPES.

Q. What would be the result if the brake pipe branch to the distributing valve broke off?

A. The locomotive and train brakes would apply.

Q. What should be done if this happens on the road?

A. Plug the end leading from the brake pipe; release the locomotive brake by placing the independent brake valve handle in *release* position and proceed.

Q. Would it be possible to use the locomotive brake in this case?

A. Yes; with the independent brake valve, always using *release* position to release the brake.

Q. What would be the result if any of the pipe connections between the distributing valve and the brake cylinders broke off?

A. It would permit a constant escape of air when the brake is applied and may cause the release of one or more of the locomotive brake cylinders, depending on where the break occurs.

Q. What should be done in a case of this kind?

A. If the pipe cannot be repaired close the cut-out cock in the pipe leading to the broken pipe. If breakage occurs next to the distributing valve reservoir, close the cut-out cock in the distributing valve supply pipe.

Q. What would be the effect if the supply pipe to the distributing valve broke off?

A. It would permit main reservoir pressure to escape and prevent the use of the locomotive brake.

Q. What should be done?

A. If repairs cannot be made to the pipe, the cut-out cock in the supply pipe should be closed or the pipe plugged.

Q. What would be the effect if the application cylinder pipe to the distributing valve broke off?

A. It would be impossible to apply the locomotive brake.

Q. What should be done?

A. The connection to the distributing valve should be plugged and the brake could then be applied, but with the automatic brake valve only.

Q. With this opening plugged and the brake automatically applied, can it be released with the independent brake valve?

A. No. It can only be released by placing the automatic brake valve handle in *running* position.

Q. If the release pipe to the distributing valve breaks off, what would be the effect?

A. It would cut out the holding feature of the automatic brake valve.

Q. With this pipe broken off would it interfere with the independent operation of the brake?

A. Yes; if an independent application was made and the equalizing parts of the distributing valve were in release position, it would allow the independent brake to release when the independent valve was moved to lap position.

Q. With this pipe broken off and the brakes automatically applied, can they be released with the independent brake valve?

A. Yes.

Q. Should any delay be occasioned by the breaking off of this pipe?

A. No. Proceed and operate the brake with the automatic brake valve but without attempting to use the holding feature.

Q. What would be the effect if the pipe connection to the spring chamber of the excess pressure head of the pump governor broke off?

A. The compressor would not operate when the main reservoir pressure was about forty pounds or over.

Q. What should be done in this case?

A. Plug the broken pipe and place a blind gasket in the pipe leading to the chamber below the diaphragm of the excess pressure head.

Q. What should be done if the pipe connection leading to the chamber below the diaphragm of the excess pressure head breaks off?

A. Plug the broken pipe and proceed.

Q. With the lower pipe to the excess pressure head plugged, or with both pipes plugged, what would control the compressor?

A. The maximum pressure head.

Q. What should be done in the event of the pipe connection to the maximum pressure head breaking off?

A. Plug the pipe.

Q. What would control the compressor?

A. The excess pressure head.

Q. In such a case, would the excess pressure head control the compressor at all times?

A. No; only with the automatic brake valve handle in *release, running,* or *holding* positions.

Q. What would happen if the handle were left in *lap,*

service or *emergency* positions or it became necessary to close the main reservoir cut-out cock for any length of time?

A. The governor then being out of commission, the compressor will continue to run until air pressure and steam pressure become approximately equal.

Q. What precaution should be taken with the governor out of commission in this way?

A. Compressor should be throttled so that too high a main reservoir pressure could not be obtained, and in case of main reservoir cock being closed compressor should be shut off.

Q. What should be done if the equalizing reservoir pipe breaks off?

A. Plug the equalizing reservoir pipe to the brake valve and the service exhaust opening. The brakes should then be applied in service by a careful use of the *emergency* position.

Q. Why should extreme care be used when operating the brake valve in this manner?

A To avoid causing quick-action and to prevent the head brakes "kicking" off when returning to *lap* position.

ROUND HOUSE INSPECTOR'S TEST.

General:

Q. What are the objects of these tests?

A. To determine the condition of the detail parts of the ET Equipment.

Q. What should be done by the round house air-brake inspector when testing the brakes preparatory to turning out the engine on the road?

A. The following cocks must be closed: The drain cocks in the main reservoirs, the brake pipe angle cocks

and the signal pipe cut-out cocks at each end of the locomotive, and the ⅜-inch cut-out cock in the dead engine pipe.

The following cocks must be opened: Main reservoir cut-out cock, distributing valve cut-out cock, the double-heading cock and cut-out cocks in the brake cylinder pipes.

Both the automatic and independent brake valve handles should be in *running* position before starting the compressor.

Q. When the locomotive brake system has become fully charged what should first be done?

A. Blow out the brake pipe and signal pipe by opening and closing quickly a number of times the angle and stop cocks, both at the pilot and rear of the tender.

Q. Why is this done?

A. To remove scale and other foreign matter that may be in the brake and signal pipes.

Q. What pressure should there be in the brake pipe and distributing valve before testing the brake?

A. The standard brake pipe pressure for the service in which the locomotive is to be used.

Q. What are the parts that should be tested first?

A. The air gages.

Q. What method should be employed to test the air gages?

A. Use a test gage that is known to be correct. This gage should be coupled to the front or to the rear brake pipe hose; then with system charged and automatic brake valve in *release* position, note if main reservoir, equalizing reservoir and brake pipe presssure as indicated by the air gages correspond with the pressure indicated on the test gage.

Q. How should the brake cylinder gage be tested?

A. Connect the test gage to the brake cylinder, make a brake application, and see that the brake cylinder gage registers with the test gage.

Q. What test should follow the gage test?

A. A test of the pump governor.

Q. How should this test be made?

A. Place the automatic brake valve handle in *running* position. In this position main reservoir pressure should register twenty pounds higher than that in the brake pipe. Then place the handle in *lap* position. In this position the main reservoir pressure should register the maximum pressure standard on the road for the class of service to which the engine is assigned.

Q. What should next be done?

A. The feed valve should be tested.

A. How should the feed valve be tested?

A. Place the automatic brake valve handle in *running* position to see that the feed valve regulates the brake pipe pressure to the proper standard.

Q. What test should follow the feed valve test?

A. A test of the automatic rotary valve for leakage.

Q. How shoula this be tested?

A. Make a 20-pound service reduction, place the handle on *lap* position and close the double-heading cut-out cock under the brake valve. Harmful rotary valve leakage will be denoted in a few seconds by a material increase of pressure in the equalizing reservoir (shown on a gage) or by the equalizing piston lifting.

Q. Would any other defect cause the equalizing piston to lift?

A. Yes; a leak from the equalizing reservoir, which will be shown on the gage, will cause this. If the piston

lifts, due to a rotary valve leak, however, the gage hand does not fall.

Q. What should next be done?

A. The locomotive brake pipe should be tested for leakage.

Q. How should test be made for break pipe leakage?

A. Charge the brake pipe and system to maximum pressure, then make a five-pound service application and observe the fall in brake pipe pressure as indicated by the *brake pipe gage,* not by the equalizing reservoir gage.

Q. What should the limit of this leakage be?

A. It should not exceed five pounds per minute.

Q. What test should be made to determine if the brake is in good order?

A. Apply the brake by making a full service application with the automatic brake valve, and if it applies properly, release by placing the automatic brake valve handle in *running* position and note if the brake shoes properly clear the wheels and the cylinder pistons return to the end of the cylinder.

Q. What other test should be made?

A. Apply the brake with the independent brake valve, noting that a full application (forty-five pounds) is registered by the red hand of the small air gage and that the hand returns to zero when the brake is fully released.

Q. With the independent brake valve handle in *quick-application* position how long should it take to get forty-five pounds of cylinder pressure?

A. From two to four seconds.

Q. How long should it then take from the time the independent brake valve handle is placed in *release* position until the flow of air from the application chamber at the brake valve ceases?

A. From two to three seconds.

Q. What should be observed regarding piston travel?

A. That the piston travel is only sufficient to give proper brake shoe clearance.

Q. What is usually about the proper piston travel?

A. Driver brakes about four inches; engine truck brake about six inches, and tender brake about seven inches standing travel.

Q. Why is too long piston travel objectionable?

A. It may cause a loss of the brake due to the piston striking the head or levers fouling, which will lengthen the time of release of the brake and cause a waste of air.

PUMP GOVERNOR TEST.

Q. Before adjusting the pump governor, what should be observed?

A. That all air pipe connections are tight and that the vent port and drain port are open.

Q. What would be the effect of a stopped-up vent port?

A. There might be a considerable drop in main reservoir pressure before the compressor would start.

Q. If, in addition to a stopped-up vent port, either diaphragm pin valve were leaking, what would be the effect?

A. The compressor would not operate when the main reservoir pressure was about forty pounds or over.

Q. What would be the effect of a stopped-up drain port?

A. The governor would not shut off the compressor.

Q. If, with the handle of the automatic brake valve in *running* position, the main reservoir and brake pipe pressures do not stand 20 pounds apart, where is the trouble?

A. In the adjustment of the excess pressure head of the pump governor.

Q. What should then be done?

A. The excess pressure head of the pump governor should be properly adjusted.

Q. Before commencing to adjust the excess pressure head, what is it important to note?

A. First—That the maximum pressure head is adjusted higher than the standard main reservoir pressure to be carried with the handle of the brake valve in *running* position. Second—That the air brake pressure is known to be correct. Third—That there is no obstruction either in the main reservoir connection to the chamber under the diaphragm of the excess pressure head or in the pipe connection to the spring chamber.

Q. How should the adjustment of the excess pressure head be made?

A. Remove the cap nut from the excess pressure head and screw the regulating nut up or down, as may be required.

Q. With the automatic brake valve handle in *lap* position if the main reservoir pressure varies from the maximum employed on the road, where is the trouble?

A. In the maximum pressure governor head.

Q. If such variation exists, what should be done?

A. The maximum head should be properly adjusted.

Q. In case of a steady blow of air from the vent port when the compressor is operating, where is the trouble?

A. A leak past the seat of one or both of the diaphragm pin valves.

FEED VALVE TEST.

Q. How should the B-6 feed valve be tested?

A. With brake released and system charged to standard pressure, open the angle cock at the rear of the tender sufficiently to represent a brake pipe leakage of from seven to ten pounds per minute and observe the brake pipe gage pointer.

Q. With this amount of brake pipe leakage, what should the brake pipe gage do?

A. It should fluctuate.

Q. What does this fluctuation of the gage pointer indicate?

A. The opening and closing of the supply valve of the feed valve.

Q. If the gage hand does not fluctuate, what does it indicate?

A. That the supply valve piston is too loose a fit, and that the brake pipe leakage is being supplied past this piston and the regulating valve.

Q. How much variation should there be between the opening and closing of the feed valve supply valve?

A. Not more than two pounds.

Q. If the variation is more than two pounds, what does it indicate?

A. Undue friction of the parts, or a sticky or dirty condition of the operating parts of the valve, causing insufficient opening past the piston.

Q. If the feed valve charges the brake pipe to a pressure higher than that for which it is adjusted, what does it indicate?

A. That the piston has been made too tight a fit by oil or water.

Q. If the feed valve charges the brake pipe too slowly when nearing its maximum, what does it indicate?

A. Either a loose fitting piston or a gummy condition of the regulating valve.

REDUCING VALVE TEST.

Q. How should the C-6 reducing valve be tested?

A. First, with the system charged to standard pressure, fully apply the independent brake (handle in *slow-application* position) and note the amount of brake cylinder pressure obtained.

Q. What should this pressure be?

A. Forty-five pounds.

Q. If, in this test, the brake cylinder pressure is other than forty-five pounds, what does it indicate?

A. A leaky supply valve, a leaky regulating valve, or that the reducing valve is out of adjustment.

Q. After completing the test, what next should be done?

A. Release the brake and make an application in *quick-application* position.

Q. How can the reducing valve be tested for sensitiveness?

A. By applying a test gage to the signal line hose, and produce a leakage of from seven to ten pounds per minute in the signal line pipe and note the fluctuation of the gage pointer.

Q. What is important in making this test?

A. It must be known that the combined strainer and check valve is in a condition to permit a free flow of air through it.

Q. What other diseases might affect the operation of the reducing valve?

A. Those given in questions relating to the feed valve.

AUTOMATIC BRAKE VALVE TEST.

Q. What should be observed concerning the automatic brake valve?

A. That all its pipe connections are tight and that the handle moves freely between its various positions and that the handle latch and its spring are in good condition.

Q. If the handle does not operate easily, what are the probable causes?

A. A dry rotary valve seat, a dry valve key gasket or a dry handle latch.

Q. What should be done?

A. Rotary valve and seat, rotary valve key and handle latch should be properly lubricated.

Q. What is the proper method of lubricating the valve and seat?

A. Close the double-heading cock under the brake valve, then the main reservoir cut-out cock and after the air pressure has escaped, remove the oil plug in the valve body and fill the oil hole with valve oil.

Q. After filling the oil hole and before replacing the oil plug, what should be done?

A. The handle should be moved a few times between *release* and *emergency* positions to permit the oil to work in between the rotary valve and its seat. The oil hole should then be refilled and the oil plug replaced.

Q. How should the rotary valve key and gasket be lubricated?

A. Remove the cap nut from the rotary valve key and fill the oil hole.

Q. Before replacing the cap nut, what should be done?

A. Push down on the key and rotate the handle a few

times between *release* and *emergency* positions; then refill the oil hole and replace the cap nut.

Q. If the handle latch becomes dry, what should be done?

A. Lubricate the sides of the latch and the notches on the quadrant.

Q. If, with the handle in *release, running, holding* or *lap* positions, there is a leak at the brake pipe service exhaust, what does it indicate?

A. That the equalizing piston valve is unseated, probably due to foreign matter.

Q. How can this leak usually be stopped?

A. By closing the double-heading cut-out cock under the brake valve, making a heavy service application and returning the brake valve handle to *release* position. This will cause a heavy blow at the service exhaust fitting and usually remove the foreign matter and allow the valve to seat.

Q. With the handle of the automatic brake valve in *service application* position, brake pipe pressure seventy pounds, how long should it take to reduce the equalizing reservoir pressure twenty pounds?

A. From six to seven seconds.

Q. From a brake pipe pressure of 110 pounds, how long should it take?

A. From five to six seconds.

Q. In case the equalizing reservoir pressure reduces considerably faster than the time given, what is the probable cause?

A. Either an enlarged preliminary exhaust port, leakage past the rotary valve, seat, lower gasket, or in the equalizing reservoir and its connections to the brake valve or gage.

Q. If the reduction is materially slower than the figures given, what is probably the cause?

A. A partial stoppage of the preliminary exhaust port or leakage into the equalizing reservoir.

Q. How should test be made for a leaky rotary valve?

A. By placing the brake valve handle in *service* position and allowing it to remain there until the brake pipe gage pointer drops to zero; then close the double-heading cock under the brake valve and place the brake valve handle on *lap*. If a blow starts at the brake pipe exhaust, it indicates a leak by the rotary valve into the brake pipe; if an increase of pressure is noted on the equalizing reservoir gage it indicates a leak past the rotary valve, or body gasket into the chamber above the equalizing piston and reservoir.

Q. During this test, if an increase of brake cylinder pressure results, or the safety valve blows intermittently, what does it indicate.

A. A leak by the rotary valve into the application cylinder of the distributing valve.

Q. With the brake valve handle on *lap* position after making a service application, if the brake pipe service exhaust continues to blow and the air gage indicates a fall in pressure in both the equalizing reservoir and brake pipe, where should the trouble be looked for?

A. In the equalizing reservoir and its connections, both to the brake valve and to the air gage, and also the inner tube of the gage.

INDEPENDENT BRAKE VALVE TEST.

Q. What are the important things to observe in connection with the independent brake valve?

A. That no external leakage exists in the brake valve

or its pipe connections and that the handle and return spring work freely and properly.

Q. What can cause the handle to move hard?

A. Lack of lubrication of the rotary valve and seat, rotary valve key and gasket or handle latch, same as with the automatic brake valve.

Q. What should be done to make the handle move freely?

A. Follow the same recommendations as prescribed for the automatic brake valve.

Q. Should the handle continue to work hard after the parts have been lubricated, where is the trouble?

A. Probably something is wrong with the return spring or its housing.

Q. How should test for leaky rotary valve be made?

A. Make a partial independent application of the brakes, place the handle on *lap*, and note if brake cylinder pressure increases gradually to the limit of adjustment of the reducing valve.

Q. Should the handle fail to automatically return to *running* position or to *slow-application* position, what is the probable cause?

A. Too much friction of the moving parts or a weak or broken return spring.

DISTRIBUTING VALVE TEST.

Q. With the system charged to standard pressure, if a five-pound service reduction in brake pipe pressure fails to apply the locomotive brake, what is the probable cause?

A. Excessive friction in one or more of the operative parts of the distributing valve.

Q. How should the test be made to determine which of the operating parts caused the trouble?

A. By recharging, and then making a slow independent application. If the brake applies properly, the indications are that the trouble is in the equalizing portion of the distributing valve; if it does not, the indications are that it is in the application portion.

Q. How frequently should the distributing valve be cleaned and oiled?

A. At least every six months.

Q. What parts of the distributing valve should be lubricated?

A. All operating parts.

Q. If water is found in the distributing valve, what is usually the cause?

A. Improper piping on the locomotive; not sufficient length of radiating pipe between the compressor and reservoirs.

Q. How should the equalizing piston, slide valve and graduating valve be removed from the distributing valve?

A. Remove the equalizing cylinder cap, and carefully pull out the piston and valves so as not to injure them.

Q. How should the application piston, application valve and exhaust valve be removed?

A. First take off the application valve cover and remove the valve, then take out the application valve pin, after which the application cylinder cover should be removed and the piston and exhaust valve carefully pulled out.

Q. Must the application valve pin always be removed before attempting to take out the application piston and exhaust valve?

A. Yes; if this is not done, damage will result, as the

piston *cannot* be taken out unless the pin is removed.

Q. With the valves removed from the distributing valve, what should be done?

A. Air should be blown through the ports and passages to remove any foreign matter.

Q. Before assembling the parts, what should be done?

A. All seats and bushings should be thoroughly cleaned and carefully examined to see that no lint is on the seats.

Q. What else should be given attention?

A. The feed groove in the equalizing piston bushing should be carefully cleaned out.

Q. What should be the resulting brake cylinder pressure from a ten-pound brake pipe reduction?

A. About twenty-five pounds.

Q. For each pound reduction of brake pipe pressure, what should be the resulting brake cylinder pressure?

A. About two and one-half pounds.

Q. If, after a partial service application has been made and the brake valve lapped, the brake cylinder pressure continues to increase, what are the causes?

A. The most probable cause is brake pipe leakage. Others may be a leak past the automatic rotary valve, the independent rotary valve, the equalizing valve, or the graduating valve in the distributing valve.

Q. What brake pipe pressure should be used when testing the ET Equipment?

A. Seventy pounds.

Q. Why?

A. With seventy pounds brake pipe pressure the point of equalization is below the adjustment of the safety valve. With 110 pounds pressure the point of equalization is above the adjustment of the safety valve

and therefore leakage could not be so easily discovered.

Q. How is the source of leaks determined?

A. By making a partial service application and observe to what figure the brake cylinder pressure rises. If it increases to fifty pounds and remains constant, it indicates brake pipe leakage.

Q. If the increase in the brake cylinder pressure is due to a leaky rotary in the automatic brake valve, how may it be detected?

A. The brake cylinder pressure will increase up to the limit of adjustment of the safety valve, causing it to blow.

Q. If brake cylinder pressure increases to forty-five pounds and stops, where may the trouble be looked for?

A. In the independent brake valve, due to a leaky rotary.

Q. With the safety valve removed and the brake applied with a partial service application, if a continuous leak exists at the safety valve connection to the distributing valve, what would probably be the cause?

A. A leaky graduating or equalizing valve.

Q. If the equalizing valve leaks, how can it be detected?

A. By a steady discharge of air through the exhaust port of the automatic brake valve when the handle of both this brake valve and the independent brake valve is in *running* position.

Q. If, with a service application there is an intermittent blow at the brake cylinder exhaust port, what does it indicate?

A. A leaky application valve, provided the application cylinder and the application cylinder pipe is tight

Q. What indicates exhaust valve leakage?

A. A continuous discharge of air from the exhaust port when the brake is applied.

Q. If after a service application the equalizing piston, slide valve and graduating valve move to release position because of graduating valve leakage, will the locomotive release?

A. On the engine from which the brakes are being operated the locomotive brake will not release, but on the second engine in double headers or helpers with the brake valves cut out (double-heading cock closed) the locomotive brake will release.

Q. Why does not the brake release on the locomotive from which the brakes are being operated?

A. Because under these conditions the automatic brake valve is on *lap;* consequently the air cannot exhaust from the application chamber.

Q. Why will the brake release on the second locomotive or helper?

A. Because the release pipe is open to the atmosphere.

Q. If the brake released after an automatic application, when the handle is placed in *release* or *holding* position, but remains applied after an independent application, where would you look for the trouble?

A. It is caused by a leak from the distributing valve release pipe, between the automatic and the independent brake valves.

Q. If the brake releases after an independent application, but remains applied after an automatic application, what would cause the trouble?

A. A leak in the distributing valve release pipe between the distributing valve and the independent brake valve.

Q. If the brake releases after either an automatic or

an independent application, what would cause the trouble?

A. A leak from the application cylinder pipe or past the application cylinder cap gasket.

Q. How could a weak or broken application piston graduating spring be detected?

A. If this spring becomes weak or broken, the application portion of the distributing valve would not be as sensitive to graduation.

Q. How should test for leakage in the application cylinder pipe be made?

A. Make a *service* application of the brake, lap the handle and note if the brake remains applied. If it does not, it indicates that the application cylinder pipe or possibly that the application cylinder cap gasket is leaking.

Q. To determine if the release pipe is leaking, how should test be made?

A. Make a service application of the brake with the automatic brake valve. If the brake remains applied with handle in *lap* position but releases when handle is returned to *holding,* it indicates release pipe leakage.

Q. If the brake cylinder pressure does not remain at that to which it is applied, what is the cause?

A. Leakage from application chamber, application cylinder or their pipe connections.

BRAKE CYLINDER LEAKAGE TEST.

Q. Can brake cylinder leakage be readily determined with ET Equipment?

A. Yes.

Q. How?

A. By noting the number of strokes which the compressor makes in a given period of time. Then apply

the brake with the independent brake valve and after the compressor has restored the main reservoir pressure again note the number of strokes. The difference in the number of strokes indicates the amount of leakage in the brake cylinders.

Q. Is there any other method of determining brake cylinder leakage?

A. Yes; apply the brake with the independent brake valve, then close the cut-out cock in the distributing valve supply pipe and observe the brake cylinder gage. The gage will indicate the amount of leakage from the brake cylinders.

Q. Can it be determined which of the brake cylinders is leaking?

A. Yes.

Q. How?

A. Apply the brake with the independent brake valve and close the cut-out cock in the distributing valve supply pipe, then close the cut-out cocks in the pipes leading to the truck brake cylinder, driver brake cylinder and tender cylinder in order, noting the gage after each cock is closed.

SAFETY VALVE TEST.

Q. What attention should be given the E-6 Safety Valve?

A. It should be noted that the safety valve is screwed properly in place, that the cap nut is screwed down on the regulating nut, making an air tight joint with the body, and that all vent holes and ports are open.

Q. If the cap nut is not screwed down properly, what would be the effect?

A. The valve and its stem would have too much lift

and the leakage of air around the threads of the regulating nut to the atmosphere would interfere with its proper operation.

Q. How should the safety valve be tested to determine if it is properly adjusted?

A. Make an emergency application of the brake, allowing the handle to remain in *emergency* position, and note if the proper brake cylinder pressure is obtained.

Q. What brake pipe pressure should be used when testing the safety valve?

A. 110 pounds.

Q. Within what limits should the safety valve limit the locomotive brake cylinder pressure?

A. Between 68 and 70 pounds.

Q. If the safety valve is adjusted at 68 pounds, and the pressure increases above 70 pounds, what would be the cause?

A. The holes leading from the spring chamber of the valve are restricted, or the piston valve has worn loose.

Q. If the safety valve permits the pressure to reduce considerably below 68 pounds before closing, what would be the trouble?

A. The holes leading from the spring chamber of the valve have been enlarged or gum or dirt has made the piston valve too close a fit.

Q. Within what limits should the safety valve limit the locomotive brake cylinder pressure for ordinary service applications (110 lbs. brake pressure)?

A. Between 65 and 70 pounds.

AIR SIGNAL SUPPLY SYSTEM TEST.

Q. In testing the air signal, what should first be done?

A. The signal pipe should be charged and all stop

cocks, joints and unions carefully examined for leakage.

Q. How can it be determined whether the proper pressure is being carried in the signal line?

A. By attaching a test gage to the signal line hose.

Q. What would a too high signal pipe pressure indicate?

A. That the reducing valve was improperly adjusted or was leaking.

Q. What effect might this have?

A. In combination with a leaky signal line it might cause the signal whistle to blow when an independent application of the brake is made.

Q. How can reducing valve leakage be determined?

A. By making a signal pipe reduction and noting if the pressure gradually increases after the standard maximum signal pipe pressure has been attained.

Q. With a reasonably tight signal pipe, if the whistle blows when an independent application of the brake is made, what would be the cause?

A. A leaky check valve in the combined strainer and check valve.

Q. If, in charging up the signal pipe the test gage indicates a too slow increase of pressure, where should the trouble be looked for?

A. Probably an obstruction in the strainer or choke fitting or a loose fitting feed valve piston.

Q. If, with the signal system of the locomotive fully charged, the signal whistle blows, what is the probable cause?

A. Leakage in the signal system and a sluggishly operating reducing valve.

Q. What is the high speed brake?

A. A more powerful brake, designed to meet the heavy brake work required on high speed passenger trains.

Q. Does the adoption of the high speed brake require any great change in the brake apparatus usually found on a locomotive or car?

A. No; simply increasing the pressure in the train pipe and auxiliary reservoirs and the use of a high speed reducing valve connected to the brake cylinders, performs the conversion.

Q. What is the standard high speed brake pressure carried in the train pipe auxiliary reservoirs?

A. One hundred and ten pounds.

Q. How much shorter distance will the high speed brake stop a train than the old standard 70-pound brake?

A. About 30 per cent., in emergency stops.

Q. Is it understood that this brake is primarily an emergency brake?

A. Yes; but it also greatly improves the service brake work.

Q. What advantage is this brake in making service stops?

A. It enables two or three full service applications to be made without recharging the train pipe and auxiliary reservoirs, and still have sufficient pressure in the auxiliary reservoirs for an emergency application if it is desired.

Q. What per cent. of brake power is used on passenger equipment cars?

A. Ninety per cent., figured from a cylinder pressure of 60 pounds.

Q. But does not the use of 110 pounds auxiliary reservoir pressure give more than 60 pounds cylinder pressure?

A. Yes; if applied in emergency, but not during ordinary service applications.

Q. What pressure will an emergency application develop in the brake cylinders?

A. About 88 pounds, if the piston travel is adjusted properly.

Q. Why will the cylinder pressure not exceed 60 pounds during a service application, if a heavy train pipe reduction is made?

A. The high speed reducing valves attached to each brake cylinder are so designed that they will vent brake cylinder pressure to the atmosphere if it exceeds 60 pounds.

Q. If the brakes are applied in emergency, which results in giving about 88 pounds cylinder pressure, will this high pressure remain in the brake cylinder until the train is stopped?

A. No; the principle of the brake is to give a high cylinder pressure when the speed is high, and to gradually reduce the pressure as the speed reduces.

Q. Then the braking power is greatest at the beginning of the application, or when the speed of the train is high, and lowest when the speed is lowest?

A. Yes; the braking force is variable, being greatest when the train speed is highest, and, reducing gradually, is least when the train speed is lowest.

Q. It is well known that to slide a wheel at high speed is next to impossible. Was it with this knowledge in view that the high speed brake was designed?

A. Yes; advantage is taken of this fact to apply the

brakes with extraordinary force when the speed is high and the wheels are rapidly revolving, and to have the braking force decrease as the train speed decreases, ending with a still powerful, yet safe braking force as the train comes to a standstill. Thus the variable braking force is practically fitted to the variable speed.

Q. Why is a variable cylinder pressure desired when stopping a train?

A. Because the friction between the brake shoes and wheels varies with the speed, it being low at high speed and high at low speed.

Q. Have any tests been made to prove that such is the case?

A. Yes; the Westinghouse-Galton tests, made in England in 1878, were the first along this line, but of later years many tests have been made, all of which proved that the faster the wheel revolved against the brake shoe the less the friction between the two, but as the speed of the wheel decreased, the friction increased.

Q. In stopping a wheel from revolving, what two forces are acting against the wheel in opposite directions?

A. The adhesion, or friction, between the wheel and the rail acts upon the wheel in one direction, tending to keep it revolving, while the friction between the brake shoe and the wheel is acting in the opposite direction, tending to stop it from revolving.

Q. As has been described, the brake shoe friction varies with the speed. Does not the rail friction, or adhesion, also vary with the speed?

A. No; tests which have beeen made to determine this prove that it is constant, regardless of the speed.

WESTINGHOUSE "P C" EQUIPMENT.

Q. How many control valve exhaust openings are provided with the "P C" equipment?

A. Three; one on the side of the control valve reservoir, and two on the equalizing portion. All are tapped for ⅜-inch pipe.

Q. If, with the brakes applied or released there should be a blow at the application chamber exhaust on side of control valve reservoir, what is the trouble, and how may it be remedied?

A. The equalizing portion is defective, and a new or repaired one should be substituted.

Q. If there is a blow at the reduction limiting chamber exhaust on the left side of equalizing portion, with brakes in release or service, what is indicated, and how may it be remedied?

A. A defective application portion, and it should be replaced by a new or repaired one.

Q. Where is the application portion located?

A. Back of the equalizing portion inside the reservoir.

Q. Should the blow occur only after 30 lbs. reduction, what is indicated?

A. A defective emergency reservoir check valve, which is the middle check valve in the equalizing portion.

Q. What should be done in this case?

A. Substitute a new check valve, or one that has been repaired.

Q. If this does not stop the blow, what should be done?

A. Substitute a new equalizing portion, or one that has been repaired.

Q. If there is a blow at the emergency piston exhaust,

which is on the right-hand side of equalizing portion, what should be done?

A. Make a 15-lb. brake pipe reduction and lap the valve. If the blow ceases it indicates that either the emergency portion, or seal on the small end of equalizing piston is defective, and a new, or repaired portion as found to be needed should be substituted.

Q. If this does not stop the blow what is to be done?

A. The equalizing portion is defective, and a new or repaired one should be substituted.

Q. In case a hard blow should occur at the service brake cylinder exhaust, located on the left side of control valve reservoir, with the brakes applied, what is the trouble and what the remedy?

A. The application portion is defective, and a new or repaired one should be substituted.

Q. If this blow occurs when the brakes are released, what is indicated and what is the remedy?

A. Either the application or the emergency portion is defective, and a new or repaired one as found upon investigation is needed, should be substituted.

Q. If, with the brakes applied, or released a hard blow occurs at the emergency cylinder exhaust, what is indicated, and what is the remedy?

A. A defective emergency portion, and it should be replaced by a new, or repaired one.

Q. If, after making the changes recommended in answers to questions previously outlined, the trouble is not overcome, what should be done?

A. The application portion should be removed and its gasket should be carefully examined, as a defect in same may be the cause of the difficulty.

THE AUTOMATIC REDUCING VALVE.

Q. What is the purpose of the automatic reducing valve?

A. To so manipulate the brake cylinder pressure that a variable braking power may be had during the period of a train stop.

Q. How is this variable pressure regulated?

A. The automatic reducing valve is so constructed that when the maximum pressure is held in the brake cylinder, the pressure is slowly vented to the atmosphere, gradually reducing that pressure faster and faster, until the minimum pressure is reached, at which time the venting is much more rapid than at the beginning.

Q. What parts compose the automatic high speed reducing valve?

A. A piston, the top of which is always exposed to any pressure in the brake cylinder, regulating spring under the piston, which is adjusted by regulating nut; a slide valve, which separates the brake cylinder pressure from the atmosphere through the automatic reducing valve.

Q. Explain the action of the automatic reducing valve.

A. As the brake cylinder pressure is always on top of the piston, there is a tendency for the piston to descend, equal to the pressure exerted thereon. On the under side of the piston is the regulating spring, adjusted by regulating nut, which has an upward pressure of 60 pounds, the standard adjustment pressure.

Q. Brake cylinder pressure then has a tendency to force the piston downward against the resistance of the regulating spring?

A. Yes; and when the brake cylinder pressure on the top side of piston is greater than the resistance of regulating spring, the piston will descend, carrying with it the slide valve.

Q. In an emergency application of the brake, how does the automatic reducing valve operate?

A. The pressure on the upper face of the piston overcomes the tension of the spring, forces the piston to its lowermost limit and draws the slide valve along with it, making a communication between the brake cylinder and the atmosphere through the apex of a triangular shaped port.

Q. How does the automatic reducing valve operate in service application of the brake?

A. As the auxiliary reservoir air is sent by the triple valve to the brake cylinder and to the upper side of piston, no effect is had on the reducing valve until such time as the brake cylinder pressure reaches a higher point than the adjustment of the regulating spring, then the piston slowly descends until the base of the triangular port b is opposite the exhaust port a, and brake cylinder pressure is quickly vented to the atmosphere.

Q. What is the advantage of such an operation after service application of the brake?

A. It prevents an over-accumulation of brake cylinder pressure, which might result in the sliding of wheels.

Q. Is the use of the high speed brake confined exclusively to through fast express trains?

A. No; it has now come into general use on local as well as through trains, and is being made the standard for all passenger equipment trains on the leading railway lines.

Q. What is the purpose of having two feed valves on this system?

A. They are to permit of changing the pressures readily from high speed to the standard pressure without the necessity of readjusting the pump governor and feed valve.

Q. How is this accomplished?

A. Turning the handle of the reversing cock to the left cuts in the 70-pound feed valve; turning the handle to the right cuts in the 110-pound feed valve. The small ¼-inch cock in the governor pipe must also be opened or closed to change the pump governor control.

Q. What pressures are the pump governor heads adjusted for?

A. The low pressure head should be set at 90 pounds, and the high pressure head at 130 pounds, slight modifications are sometimes made in connection with this pressure to suit the local conditions.

Q. Is there more than one way of coupling up the pump governor heads?

A. Yes; the low pressure head is sometimes coupled to the reversing cock, such as it is with "Schedule U."

Q. In handling the high speed brake, should it be operated in a similar manner as the old standard 70-pound brake?

A. Yes; the rules covering the handling of the 70-pound pressure brake on passenger trains apply to the high speed brake, they being heavy initial reductions and the two application stop.

Q. What style of triple valve is used on tenders with the high speed brake?

A. Quick action triple valve.

Q. When the engine is equipped with a truck brake,

is a separate reducing valve used with the truck brake cylinder?

A. No; the apparatus is so arranged that one reducing valve takes care of the driver and truck brake cylinders.

Q. In making an application of the brakes when the high speed pressure is used, will a 20-pound reduction give any more braking power than if the same reduction were made with the 70-pound pressure?

A. No; it appears, however, to give a little more, but this is due to the air entering the cylinder a little quicker.

Q. If when making a brake test a 20-pound reduction is made, one of the reducers commences to blow, what would this indicate?

A. It is either not adjusted properly, or else the car has very short piston travel, the latter being the usual trouble.

Q. What would be the per cent. of braking power on a car if an emergency application is made and 88 pounds cylinder pressure is had?

A. If the car is braked on a basis of 90 per cent., with 60 pounds cylinder, 88 pounds of cylinder pressure would give about 130 per cent. of braking power to the weight of the car braked.

Q. In handling a light engine, should the high speed brake pressure be used?

A. No; the reversing cock handle should be turned to the left and the 70-pound pressure used.

Q. Why are the recent reducing valves supplied with a long, straight cap nut on the lower end instead of the usual round cap form?

A. It was found that in cold weather water would drip to the lower extremity of the cap, hang there in

drops and finally freeze, thus stopping up the small port in the cap nut. The straight sided cap nut prevents freezing of the hole in the cap.

Q. Why is this hole placed in the cap nut?

A. To permit any leakage of brake cylinder pressure past the piston into the spring case to escape.

Q. What harm would the accumulation of such leakage amount to if permitted to accumulate in the spring case?

A. It would add its pressure to that of the regulating spring, thereby tending to force the piston upward, thereby closing ports b and a, too early, and holding too high a pressure in the brake cylinder.

Q. Is it important then that the hole in the cap should be kept open?

A. Yes; sometimes this becomes stopped up, either carelessly or purposely, and the valve is given the erratic action already described.

Q. In high speed brake service is it necessary that greater care should be given the triple valve and other parts?

A. Yes; the greater pressure on the back of the slide valve of the triple valve in high speed brake service tends to squeeze out the lubrication from between the face and seat of the slide valve, thus rendering those parts dry, and creating greater friction, which prevents as smooth an operation of the slide valve on its seat as would the 70-pound brake. Sometimes more frequent lubricating is necessary on this account.

Q. What other difficulties are encountered in the triple valve in high speed brake service?

A. That resulting from moisture in the air reaching the triple valve, which assists in washing off the lubri-

cant, and creating a film of ice in cold weather between the slide valve and its seat, thus creating undue friction of the parts which create a tendency for the triple valve to give undesired quick action.

Q. Are there any other points to be watched on high speed brake service with respect to undesired quick action?

A. Yes; the equalizing piston of the brake valve should be kept in good condition to operate smoothly, else undesired quick action may be caused.

Q. What attention should be given the high speed reducing valves?

A. On engines and tenders they should be cleaned and oiled every six months, on cars once a year.

Q. What kind of oil should be used in lubricating the reducing valves?

A. The same as is used in the triple valves; a high grade mineral oil.

Q. In cleaning the reducing valve is it necessary to relieve the tension on the adjusting spring?

A. No; the lower case can be removed and replaced without changing the adjustment mechanism.

WESTINGHOUSE HIGH PRESSURE CONTROL SYSTEM, "SCHEDULE U."

Q. What is the "Schedule U" or "High Pressure Control System?"

A. It consists of a duplex device designed to meet the needs of special air brake service, where the pressures ordinarily employed may be quickly changed to higher pressures to meet more difficult conditions, such as controlling trains made up of heavily loaded cars.

Q. For what class of service is this device particularly designed?

A. For coal, iron and other mineral carrying roads in mountainous districts, where loads are carried down hill and empties hauled up. The usual pressure may be employed on the light train up the grade where little braking power is demanded or needed, and by merely reversing a cock the apparatus may be changed to give a predetermined higher pressure with which to operate the loaded train down the grade.

Q. Briefly describe the "Schedule U," or "High pressure control system?"

A. It is simply a modification of the usual equipment used on an engine with the addition of a duplex pump governor, two feed valves, reversing cock and bracket, and safety valves connected to driver and tender brake cylinders.

Q. Describe the operation of the apparatus.

A. The two pump governor heads are adjusted for 90 and 110 pounds respectively. Likewise, the two feed valve attachments are set for 70 and 90 pounds. To operate the low or ordinary pressure feature, the handle of the reversing cock is turned to the left. This cuts out the 110-pound governor and 90-pound feed valve, and renders operative the 90-pound governor and the 70-pound feed valve. Thus the high pressure control parts are cut out and the low pressure cut in. By reversing the position of the reversing cock handle, the low pressure parts are cut out and the high pressure parts cut in.

Q. How are the two feed valves arranged so that they can both be connected to the brake valve?

A. They are attached to the reversing cock, which in

turn is connected to the brake valve by pipes and special pipe bracket. However, only one valve has any connection with the brake valve at one time, this depending upon the position of the reversing cock handle.

Q. Does turning the reversing cock handle change the pump governor control as well as the feed valve?

A. Yes; this is arranged by having the low pressure head of the governor attached to the low pressure side of the reversing cock.

Q. When making the application of the brakes when the 90 pounds train pipe pressure is used, how much of a reduction should be made to fully equalize the power with standard 8-inch piston travel?

A. About 27 pounds.

Q. Does a 5, 10 or 15-pound service application with the 90-pound train pipe pressure develop any greater braking power than it would if only 70-pound train pipe pressure is used?

A. No; the brake power will be about the same and no gain had unless the train pipe reductions are continued beyond what would be necessary to fully equalize the 70-pound train pipe pressure.

Q. Would not the high pressure permitted by the 110-pound governor and 90-pound feed valve tend to loosen driving wheel tires by excessive heating and slide wheels under a tender partly relieved of its coal and water?

A. No; as safety valves are supplied for the driver and tender brakes to limit the pressures there to 50 pounds. On very long and heavy grades, it is generally desirable to cut out the driver brakes and use the water brake on the engine to assist the tender and train brakes.

Q. If the reversing cock should leak, what would happen?

A. A leakage or mingling of pressures would follow and interfere with the proper operation of the device. This part should be looked after with the same care given the other parts in ordinary service.

Q. Does the use of "Schedule U," or high pressure control apparatus require any change to be made in the car brake equipment?

A. No; the standard car brake apparatus is used and operated in the usual manner.

Q. If all cars in the train were loaded except two or three, would it be safe to use the high pressure?

A. No; as the wheels on the light cars may slide. It, however, might be advantageous to cut out the brakes on these few cars and use the high pressure on the others.

WESTINGHOUSE DUPLEX MAIN RESERVOIR CONTROL.

Q. In what respect does this main reservoir control arrangement differ from what is usually found on a locomotive?

A. In the use of a duplex pump governor, in which one head is adjusted for a low pressure, and one for a high pressure as shown, and connected to different parts of the brake valve.

Q. What is the object of this arrangement?

A. To permit of accumulating a high main reservoir pressure with which to release the brakes and recharge the auxiliary reservoirs, and only requiring the pump to operate against this high pressure for the short time the brakes are held applied.

Q. What pressures are the governor heads usually adjusted for?

A. The low pressure head for 85 pounds, the high pressure head for 110 pounds.

Q. By what means is the pump control transferred from one head to the other?

A. By the movement of the brake valve handle.

Q. In what positions of the brake valve does the low pressure head control the pump?

A. In running position, or full release.

Q. Explain how the pump governor heads are coupled up in this arrangement.

A. The high pressure head is coupled to the usual main reservoir connection of the brake valve, while the low pressure head is connected to port A in the brake valve, which leads to the running position port.

Q. Explain how the control of the pump can be transferred from one head to the other.

A. As the low pressure head is coupled to the running position port f of the brake valve, it is, therefore, subject to main reservoir pressure when the brake valve is in running or release position, which allows the air pressure to pass to the low pressure head, causing the pump to stop when the main reservoir pressure is equal to the adjustment of this head. However, in placing the brake valve in lap, service or emergency positions, the main reservoir pressure, being cut off from the feed valve, is also cut off from the low pressure governor head, which permits the pump to run until the pressure in the main reservoir is equal to the adjustment of the high pressure head, which will then stop the pump.

Q. In the description of the brake valve it was stated that the running position port f was closed in release

position, therefore, how can the air pressure reach the low pressure governor head to cause it to stop the pump?

A. While it is true the running position port f is closed in release position, air pressure reaches the low pressure governor head by passing back from the train pipe through the feed valve attachment.

Q. Will the pipe connection and port A be found in all brake valves?

A. No; however, all brake valves supplied recently have this connection, but it can be readily placed in any of the standard form of valves.

Q. With this duplex governor arrangement is it necessary to have one of the governor vent ports plugged?

A. Yes; one of these ports must be closed in all cases where the duplex pump governor is used.

THE WESTINGHOUSE COMBINED AUTOMATIC AND STRAIGHT AIR BRAKE.

Q. What is the combined automatic and straight air brake?

A. A device by which either the automatic brake, or the straight air brake may be operated on the engine and tender, at the discretion of the engineer, without the operation of one brake being interfered with by the other.

Q. Is it necessary to prepare one brake, by cut-out cocks, movement of brake valve handles, or otherwise, to operate either brake?

A. No; the arrangement of the parts is such that the engineer may go from one brake to the other brake without any preparatory movement.

Q. Each brake then is independent of the other?

A. Yes; although they are combined and attached to

the same common system, still they are entirely independent of each other in their action.

Q. What comprises the combined automatic and straight air brake?

A. The addition of a straight air brake valve and a few simple parts, which permit the use of the straight air on the engine and tender, without interfering with the automatic brake apparatus, both brakes being cut in at all times.

Q. The combined automatic and straight air brake then is merely the straight air brake apparatus added to the automatic brake which is already on the engine and tender?

A. Yes; and while they are combined, yet they are strictly separate.

Q. Describe the operation of the combined automatic and straight air brake.

A. Connection with the automatic brake is made by the straight air brake at three points, viz., to the main reservoir, and to the brake cylinder pipes of both driver and tender brakes.

Q. From where is the straight air supply taken?

A. From the main reservoir pipe to the automatic brake valve, where clean, dry air is insured.

Q. Trace the course of the air used to operate the straight air brake.

A. The pressure is taken from the main reservoir pipe supplying the automatic brake valve, is passed through a reducing valve which is set at 45 pounds, then through the engineer's straight air valve to the double seated check valve and to the brake cylinders.

Q. Describe the release of the straight air brake.

A. When the straight air brake valve is placed in re-

lease position, a direct opening is made from the cylinders, through the double seated check valve to the straight air brake pipe, thence through the engineer's straight air brake valve to the atmosphere.

Q. Where is the double seated check valve located?

A. One of these valves is inserted on both the engine and tender, in the pipe leading from the triple valve to the brake cylinders, so that in brake operation, either automatic or straight, the pressure will have to pass through the check valve in going to and from the brake cylinders.

Q. Name the principal parts of the combined automatic and straight air brake.

A. Assuming that the automatic parts are already well known, the remaining parts, those of the straight air portion, are the automatic reducing valve, the engineer's brake valve, the double seated check valves, the safety valve and the special hose connection.

Q. What is the purpose of the special hose connection?

A. It is a special single hose which connects the straight air brake pipe between the engine and tender. It is subject to the low pressure only at 45 pounds, and is, therefore, less liable to burst. This low pressure insures greater length of life of the hose.

Q. Describe the construction of the double seated check valve?

A. It consists of a suitable casing holding the piston, which has, at each end, a leather face. These leather faces make an air-tight joint. The piston valve is shorter than the distance between the two seats b and d, and the bush in which it works has two series of ports, c and c1. With the piston valve against seat b, ports c

afford a free passage for the air from the straight air brake valve to the brake cylinder. The opening leading to the triple valve, which is now in release position, is closed so no straight air leakage can occur.

Q. With the straight air brake valve in release position, where it should be when not in use, assume that an automatic brake application is made. Describe the passage of the air.

A. The air from the triple valve, on entering the double seated check valve, will force the piston valve to the right, against seat d, thus preventing any escape of pressure at the straight air brake valve and opening ports c1 so the air can flow uninterrupted into the brake cylinder.

Q. Should this double seated check valve be located in any particular position?

A. Yes; in a horizontal position, so this piston valve will not be subject to gravity effect, and only be moved by air pressure. Then the mere act of making either an automatic or straight air application will cause the piston valve to automatically move to the proper position.

REDUCING VALVE AND PIPE BRACKET.

Q. Describe the location and operation of the reducing valve and its pipe bracket.

A. The reducing valve and its pipe bracket are located in the main reservoir pipe, leading to the straight air brake valve. The reducing valve is the well known slide valve feed valve attachment to the brake valve.

Q. What is the purpose of the reducing valve?

A. To reduce the main reservoir pressure used, to a safe amount. It should be set at 45 pounds, so that no more than that pressure can reach the brake cylinders.

Q. In a straight air application should more than 45 pounds of pressure get to the brake cylinder, where should we look for the trouble?

A. In the slide valve reducing valve.

THE SAFETY VALVE.

Q. What is the purpose of the safety valve?

A. In the event of the reducing valve getting out of order, due to dirt or any foreign substance deranging it, and an over pressure getting to the brake cylinder, the safety valve, being screwed into either the brake cylinder or the brake cylinder pipe, will blow off the surplus pressure.

ENGINEER'S STRAIGHT AIR BRAKE VALVE.

Q. Describe the action of the straight air brake valve?

A. This valve is practically a three-way cock in its operation, but is, on account of its special construction, much superior to the three-way cock. There is no friction to it, and opportunity for leakage is reduced to a minimum. The engineer is able to tell by the touch of the valve just how much of an opening is made. It is designed to run for a long time without repairs.

Q. How should the straight air brake valve be connected up?

A. Within convenient reach of the engineer, both in running ahead, and looking back when switching. The letters cast on the body indicate respectively the main reservoir, train pipe and exhaust connections.

Q. How many positions has the straight air brake valve?

A. Three; Release, Lap and Application.

Q. Name the essential parts of this valve?

A. The handle, the shaft, to which the handle is connected, two check valves which are operated by the shaft.

Q. What are the functions of the check valves?

A. One controls the supply of air from the main reservoir; the other controls the exhaust from the cylinder.

WESTINGHOUSE 1¼-INCH PUMP GOVERNOR.

Q. What is the object in applying this enlarged type of governor to the system?

A. On locomotives where two air compressors are in use it has been found that the standard 1-inch governor will not allow sufficient steam to pass to the pump under certain conditions when there is a great demand for air pressure.

Q. Describe the arrangement in use with the 1-inch governor for two compressors.

A. A 1-inch governor complete is connected in the steam supply pipe to one compressor, while a 1-inch governor steam valve portion only is connected in the branch pipe to the second compressor.

Q. Describe the improved system of regulation.

A. A 1¼-inch governor, and 1¼-inch steam valve replace the 1-inch governor and valve.

Q. What advantage is gained by this arrangement?

A. It has ample capacity for two 9½-inch, or two 11-inch compressors.

WESTINGHOUSE CENTRIFUGAL DIRT COLLECTOR.

Q. Where is this device connected?

A. In the branch pipe between brake pipe and triple valve.

Q. What is its function?

A. To collect all dirt and foreign matter in the brake pipe, and prevent its passing into the triple valve.

Q. Describe the operation of this dirt collector.

A. It is so constructed that, due to the combined action of the centrifugal force, and gravity, the dirt, etc., is automatically eliminated from the air passing through the collector, and is deposited at the bottom of the device.

Q. How is the collector cleaned?

A. By removing a small plug at the bottom, and this can be done without breaking any pipe connections whatever.

Q. What other advantage attends the use of this device?

A. It operates to materially reduce the work of cleaning and oiling the brake equipment to which it is attached.

NEW YORK DUPLEX AIR PUMP.

QUESTIONS AND ANSWERS.

Q. How many sizes are there of the New York Duplex Air Pump?

A. Four; known as Nos. 1, 2, 5 and 6.

Q. How many cylinders has the duplex air pump?

A. Four; two steam and two air cylinders.

Q. Give the dimensions of each size pump.

A. The No. 1 pump has both steam cylinders 5 inches each in diameter; one air cylinder, known as the high pressure air cylinder, 5 inches in diameter; and one air cylinder, known as the low pressure air cylinder, 7 inches in diameter.

The No. 2 pump has both steam cylinders, 7 inches each in diameter; one high pressure air cylinder 7 inches in diameter, and one low pressure air cylinder 10 inches in diameter.

The No. 5 pump has both steam cylinders 8 inches each in diameter, one high pressure air cylinder 8 inches in diameter, and one low pressure air cylinder 12 inches in diameter. The stroke of the Nos. 1 and 2 pumps is 9 inches; that of the No. 5 is 12 inches.

The No 6 pump has both steam cylinders 7 inches in diameter, one high pressure air cylinder 7 inches in diameter, and one low pressure air cylinder 11 inches in diameter The stroke of the No. 6 pump is 10 inches.

Q. What is the relative position of the steam and the

air cylinders with respect to each other when the pump is in position on the locomotive?

A. The air cylinders are above the steam cylinders.

Q. What are the relative volumes, or capacities, of the high pressure and the low pressure air cylinders of each pump?

A. The low pressure air cylinder of each size of air pump has a volume, or capacity, about double that of the high pressure air cylinder.

Q. Are the steam cylinders of each of these pumps always the same size as the high pressure air cylinder?

A. Yes.

Q. Describe the steam end of the pump.

A. The steam end of the pump consists of two steam cylinders of equal diameter, and a steam head, having in it two reversing valve chambers and two reversing slide valves, one of each for each steam cylinder. The steam pipe connection, from the boiler, is made to this steam head, and the exhaust connection, for the exhaust steam from the cylinders, is also made to this steam head at the opposite end.

Q. How is the steam distributed in the duplex pump?

A. The piston in each steam cylinder operates the reversing slide valve that controls the flow of steam into the other steam cylinder, and from that cylinder to the atmosphere.

Q. How is this accomplished?

A. By locating the slide valve for the right steam cylinder in the valve chamber under the left steam cylinder, and the slide valve for the left steam cylinder in the valve chamber under the right steam cylinder; and by crossing the steam ports as shown in the drawings.

Q. Describe the steam valves and the seats.

A. They are ordinary D slide valves, such as are used in locomotives; they admit steam to the cylinder by the outside edge, and exhaust it from the cylinder through a cavity in the center; and the seats have three ports, two steam and one exhaust, the exhaust port being between the two steam ports.

Q. Which piston will start first when steam is admitted to the pump?

A. The right, or what is commonly known as the low pressure piston. On account of the arrangement of the steam ports, and design of the reversing valve gear, the low pressure piston will always be the first to start from rest, and will lead the other or high pressure piston.

Q. What actuates the steam valves?

A. Valve stems, familiarly known as reversing valve stems or tappet rods, which are attached to the steam valves, and extend into the hollow piston rods.

Q. How are the tappet rods moved?

A. The piston rod is made hollow on the steam end for a distance sufficient to clear this valve stem; a plate is bolted on to the steam piston head in such a manner as alternately to strike a button head, and a shoulder, on the tappet rod, just before the stroke of the piston in either direction is completed, and thus moves this rod up and down a distance equal to the travel of the valve, changing the steam valve from one position to the other in the steam chest.

Q. Does the upper steam port in each steam chest lead to the upper end of its respective steam cylinder?

A. No; the upper port in the left steam chest leads to the lower end of the right cylinder, while the upper port in the right chest leads to the upper end of the left cylinder.

Q. Do both pistons of the duplex pump move at the same time?

A. No; after one piston makes a stroke, it waits until the other makes a stroke.

Q. Explain the movement of the pistons.

A. Both pistons and steam valves being at rest in the lower end of the cylinders, when steam is turned on, the right piston makes a stroke up; at the completion of this stroke, the piston changes the position of its reversing slide valve, causing the left piston to take steam and make a stroke up. At the completion of the up-stroke of the left piston, this piston changes the position of its reversing slide valve, causing the right piston to take steam and move down.

When the low pressure piston completes its down stroke it shifts its reversing slide valve so as to admit steam to the upper end of the opposite cylinder, so that the high pressure piston makes its down stroke.

Q. Describe the air end of the duplex pump.

A. It consists of two air cylinders, one larger than the other, and of six (the No. 5 pump has 8) air valves, with their seats and cages. The larger air cylinder has a capacity about double that of the smaller air cylinder. Two of the air valves, upper and lower, are known as the air inlet valves, simply; two, upper and lower, located just above, are called the intermediate air inlet and discharge valves; and two, located in the final discharge passage of the high pressure cylinder, are known as the final discharge valves. The No. 5 pump has independent air inlet and air discharge valves.

Q. Where are the air valves located?

A. The air inlet valves are located in the air passages leading from the atmosphere to the low pressure air

cylinder; the intermediate air inlet and discharge valves in air passages leading from low pressure cylinder to high pressure cylinder; the high pressure and the final discharge valves in passages leading from high pressure cylinder to the main reservoir.

Q. Explain how free air is taken into the air cylinders.

A. The low pressure piston moves up first to the end of its stroke, creating a vacuum behind it, and free air from the atmosphere follows it into the low pressure air cylinder through the lower air inlet valve; the high pressure piston then moves up to the end of its stroke, the air from the atmosphere follows it through the lower air inlet valve and lower intermediate air inlet and discharge valve into the high pressure cylinder; on the down stroke of the low pressure piston air is taken into the low pressure cylinder at the upper end from the atmosphere through the upper air inlet valve in the same manner as it was taken in at the lower end on the previous up stroke; on the down stroke of the high pressure piston, air is taken into the high pressure air cylinder through the upper air inlet valve and intermediate air inlet and discharge valve in the same manner as on the previous up stroke.

Q. Explain how the air is discharged from the air cylinders.

A. The low pressure piston moving up compresses the air in front of it and discharges it past the upper intermediate air inlet valve and discharge valve into the high pressure air cylinder; the high pressure piston then moves upward, compressing the air in front of it to a pressure equalling that in the main reservoir, and then discharges it past the upper final discharge valve into the discharge pipe and main reservoir. This operation is repeated

through the lower air valves on the down strokes of the air pistons.

Q. What air pressure does the low pressure piston always work against?

A. About 40 pounds, after the pressure in the main reservoir has reached this amount.

Q. How much pressure does the high pressure piston work against?

A. When about 30 or 40 pounds pressure has accumulated in the main reservoir the high pressure piston always starts on its stroke against the pressure accumulated in its cylinder by the low pressure piston, and must compress the air it contains to a pressure slightly above that in the main reservoir in order to raise the final discharge valve, and discharge the air to the reservoir.

Q. What should be known about the air pump before leaving the round-house?

A. That the piston rod packing does not leak; that there are no unusual knocks or pounds; that the steam exhausts are regular; and that the air-compressing capacity is normal.

DISORDERS AND REMEDIES.

Q. What will be the result if the rod packing blows out?

A. It will blow the oil from the rod and swabs. If it is the air end high pressure rod packing that is blowing, it will lower the capacity of the pump very materially, and the cushion which the pump should have to prevent the piston from striking the head will be lost.

If it is the rod packing on the steam end that is blowing, it will permit a waste of steam from the steam cylinders, and a large portion of this waste steam will be

taken in at the lower air receiving valves, helping to increase the quantity of water which gathers in the main reservoir.

Q. Give the common causes for pounding of pump.

A. The loss of air cushion to stop the pistons at the completion of the stroke, due to air piston packing or air cylinder packing leaking, and on modern engines, high pressure steam and racing the pumps.

Q. What are the other causes for pump pounding?

A. Loose reversing plates on the steam piston heads; badly worn button head on the end of valve stem; pump loose on its bracket fastenings to boiler; back leakage through the final discharge valve, and racing the pump against low main reservoir pressure.

Q. Suppose either of these troubles had existed and had been remedied and the pump still pounds, what is wrong?

A. It will probably be found that either the steam or the air piston head is loose on the rod, which is probably the result of loss of cushion and of permitting the piston to strike the head.

Q. What are the causes for the steam exhausts to sound irregular?

A. Air leakage from the main reservoir back into the high pressure cylinder, from the high pressure cylinder into the low pressure cylinder, or an air valve stuck to its seat.

Q. What is wrong if the steam exhausts sound in two pairs, one pair spaced well apart, and the other pair very close together?

A. An intermediate air valve, or a cylinder-head gasket is leaking at a point between the two cylinders.

Q. How could this cause it?

A. By permitting the air from the high pressure cylinder to pass over into the low pressure cylinder, thus forcing the low pressure piston away from its cylinder end, instead of forcing the air into the main reservoir. As a result, when the low pressure piston takes steam, it has both steam and air pressure to cause it to make a quick stroke, which brings two steam exhausts very close together.

Q. What is wrong with the pump when the spaces between three exhausts are about equal and the space between the third and fourth exhaust is very long?

A. A discharge valve is probably broken, or the upper air cylinder gasket is leaking badly between the final discharge valve cavity and air cylinder; or the lower intermediate valve seat is loose and has worked up sufficiently to raise the intermediate air valve against its stop post.

Q. What will be the result if the upper intermediate valve seat works loose?

A. As it forms the lift stop for the upper air inlet valve, the seat will work down and prevent the opening of the receiving valve.

Q. When an air pump stops of its own accord, what should be done to correct the trouble?

A. First examine the pump governor carefully to see that the relief ports are open; that is, the small relief port above the governor piston, or in the diaphragm body (see pump governor) and also the one in the spring case. If a constant blow of air is found at the little port above the governor piston it is an indication that the governor is at fault, and it should be examined and repaired.

If it is found that the governor is in perfect order, then jar the steam head lightly. If this does not start the pump close the air pump throttle, open the waste cock on

the steam chest of the pump, and allow all steam to drain away, then open the pump throttle.

Q. If, after making the throttle test, the low pressure piston moves up and stops at the upper end of the stroke, and the high pressure piston refuses to move, where should the trouble be looked for?

A. In the steam reversing gear on the right, or low pressure, side. Probably the valve stem has broken, or the reversing plate has worn through.

Q. After the throttle test, suppose the low pressure piston moves up, then the high pressure, too, but the low pressure piston fails to move down, what is the probable cause of the trouble?

A. The valve stem is probably broken, or the reversing plate worn through on the high pressure side.

Q. How should you test for back leakage from the low pressure air cylinder through air inlet valves?

A. By holding the hand on, or close to either of these valves while the low pressure piston is moving toward it; if they leak, air will be felt blowing past them.

Q. How can leakage past intermediate valves be detected?

A. By the earlier movement of the low pressure piston away from the defective valve, and the weak intake of air at the inlet valves, upper or lower, as the case may be, and also by the heating of the pump.

Q. How can leakage past the final discharge valves in high pressure cylinder be detected?

A. By the slower movement of both the low and the high pressure pistons toward the leaky valve, and the quicker movement of the high pressure piston away from it.

Q. What will be the result if either of the steam piston heads pulls off the rod?

A. The pump will stop.

Q. How could you tell that a steam piston head had pulled off?

A. A hard steam blow at the exhaust will be noticed, the same as though a blower was turned on full.

Q. Should the pump stop on account of a piston rod nut working off, how could the loose nut be located?

A. The piston will strike hard on the air end. By removing the oil cups it can be located by running a piece of wire through the oil cup hole.

Q. Could this defect be remedied on the road?

A. If the top air head is removed, the nut can be put back on the rod, or removed entirely from the cylinder, with very little trouble. Usually, however, but little can be done on the road in the way of extensive repairs.

Q. What usually causes the intermediate air inlet valves to stick open?

A. If the low pressure cylinder is given too much oil it will collect on the intermediate discharge valve, and probably cause it to stick open.

Q. What are the probable causes for the air pump running hot?

A. Leaks by the piston rod packing; also a leaky intermediate discharge valve; leaky receiving valves or badly worn packing rings in the air end, and racing under high pressure steam.

Q. If the pump runs hot what should be done to cool it off?

A. If the air valves are clean, and the piston rod packing tight a small quantity of valve oil should be used in the high pressure air cylinder, and the pump run as slow

as possible, for a short period of time, to give it a chance to cool.

Q. How should an air pump be started?

A. The pump drain cock should be opened until all water is drained off, and then the pump started very slowly, running it slowly until 35 or 40 pounds air pressure is accumulated in the main reservoir. This pressure is needed to form a cushion for the air piston.

Q. Why should the pump be started slowly?

A. Because all locomotive air pumps depend more or less on the air pressure in the main reservoir cushioning the air pistons to prevent them from striking the heads, and starting them up rapidly causes the pistons to pound and get loose.

Q. How fast should the pump be run, and how should the steam cylinders be lubricated?

A. Just fast enough to maintain the maximum pressure and the train pipe leakage, and oil should be fed continuously to the steam cylinders, according to the work it is doing.

Q. If this pump is run at a high rate of speed would any more air be compressed than at a moderate speed?

A. As the air valves must have time to seat, the pump will do better at a reasonable speed, not over 60 double strokes per minute.

THE NO. 5 DUPLEX AIR PUMP.

Q. Is there any difference in principle of operation between the No. 5 Duplex Air Pump and the Nos. 1 and 2 Duplex Pumps.

A. No; the principle of operation is the same.

Q. In what particulars does the No. 5 pump differ from the others?

A. Principally in design and proportions of parts, and in having larger pumping capacity.

Q. In what ways is the design of the No. 5 pump an improvement over the others?

A. In the air end an independent set of air inlet valves is provided for the high pressure air cylinder, and each air valve for the air cylinders is in a cage by itself, where it is easily accessible for repairs and renewals, and air inlet passages of large capacity are provided for the air inlet valves.

In the steam end the reversing slide valves are provided with flat seats and the reversing valve chamber caps are bolted to the steam head with tap bolts, instead of being screwed in, as in the other pumps.

The stroke of the pump is considerably increased, the ratio of clearance space to cylinder volume is materially reduced.

Q. What benefit is derived from reducing the clearance spaces of the pump cylinders?

A. It increases the efficiency of the pump in both the air and steam ends, and materially reduces the chances of heating and damage due to working the pump too fast.

Q. What size pipe is used with the No. 5 pump for the various connections?

A. For the air discharge to the main reservoir and for the steam exhaust, 1½-inch pipe is used. For the steam supply 1¼-inch pipe is used, although 1-inch pipe may be used with good results.

LUBRICATION OF AIR CYLINDERS.

Q. How many styles of automatic oil cups are there?

A. Two, one known as style A, and the other style B.

Q. What is the difference between the two styles of automatic oil cups?

A. Style A has a fixed feed, while style B has an adjustable feed.

Q. What can render the operation of the cup defective?

A. Should scale or dirt get into the small feed port in the cap or adjustable needle feed on top of the center post, blocking it up, then the cup would not feed properly.

Q. In filling up the cup with oil, should care be taken to see that the oil is clean?

A. Yes; since the feed port through the oil cup must be very small, care should be taken to see that the oil is perfectly clean before being put into the cup.

Q. Should the automatic oil cup be filled level full?

A. No; in filling the cup leave a little space in the top so that as the cylinder warms up, a little room will be left for expansion of the oil, and so that there will be no waste.

Q. How often should these cups be filled with oil?

A. That will depend upon the service in which the pump is employed and the amount of work it is required to do.

Q. What kind of oil should be used in the automatic oil cup?

A. Good valve oil always; never use engine oil.

Q. Why should engine oil never be used to lubricate the air cylinder?

A. As the temperature in the air cylinders, due to the compression of the air, is usually higher than the flashing point of engine oil, this oil cannot lubricate them properly. Good valve oil should always be used for lubricating the

air cylinders, because it remains oil instead of gas at a higher temperature than the air cylinders usually reach.

Q. When the governor causes the pump to run very slowly or stop momentarily, will the automatic oil cup feed oil at the same rate as when the pump is running at its normal rate?

A. No; the automatic oil cup can feed oil only when the pistons are moving. When the pump is stopped the automatic oil cups cease to supply oil to the air cylinders, and retain what remains in the cup until the time when the pump is again started.

Q. Can the cup be filled without stopping the pump?

A. Yes; as easily as when the pump is stopped.

Q. Why is automatic lubrication of the air cylinders more necessary now than formerly?

A. Because of the much harder work the air pump is required to do, and the inability of the engineman to lubricate it frequently enough by hand to prevent groaning and cutting.

PUMP GOVERNORS.

Note.—As the construction and action of the single styles of the New York pump governors are practically the same as the Westinghouse single governors, the questions and answers pertaining to the Westinghouse will also apply to the New York type of single governor.

DUPLEX PUMP GOVERNOR—HIGH PRESSURE CONTROL.

Q. When the duplex pump governor is used for the "double pressure" system, how is it piped?

A. Both tops are connected to chamber E at the brake valve, or the brake valve governor connection proper, in

front of the feed valve, and a tee for dividing the connecting pipe is put in at a convenient point; a stop cock is placed between the tee and the low pressure governor top.

Q. How are these governor tops adjusted?

A. One is adjusted to operate when the ordinary brake pipe pressure of 70 pounds has accumulated, and the other, when using the high pressure control, is usually adjusted at 90 pounds, and sometimes 100, to operate when this pressure has accumulated in the brake pipe.

Q. When it is desired to use the higher brake pipe pressure, what is it necessary to do?

A. To cut out the low pressure governor top. This is done by closing the stop cock in the branch pipe to this top, thus placing the control of the pump under the high pressure top.

Q. For what class of service is the high pressure control used?

A. It is used on coal and mineral roads and in places where the majority of the trains are hauled with the cars empty in one direction, and with them loaded in the other; the light or ordinary pressure is used on trains when running with the cars empty, and the higher pressure is used on them when they are loaded.

Q. In addition to the duplex pump governor, properly piped, what other apparatus is necessary?

A. Safety valves, such as are used with the combined automatic and straight air brake, are necessary for the driver brakes, tender brakes, and for the engine trucks if it has a brake.

Q. Why are safety valves necessary for the brake cylinders named?

A. Because the braking force upon the locomotive is

calculated from a brake pipe pressure of 70 pounds to give all the wheels will stand ordinarily, and the weight of the locomotive hardly ever varies much; so that if a higher braking force were employed one time than another it would probably tend to slide the wheels.

Q. When using the "high pressure control" how much excess pressure is carried?

A. Just the same as with the ordinary pressure, about 20 pounds.

TRIPLEX GOVERNOR.

Q. In what service is the triplex governor used?

A. It is used in place of the duplex with the "high pressure control" system, in freight service on both level and mountainous roads, and also for high speed passenger service.

Q. How is the triplex governor piped up?

A. One top is piped direct to the brake pipe connection at the brake valve, and sometimes to the brake pipe direct, below the cut-out cock, and this top is adjusted for the higher brake pipe pressure; in this pipe a tee is placed, and connection from this tee is made to another governor top, which is adjusted for the lower brake pipe pressure; the third top is piped to the main reservoir pressure direct, either at the brake valve, or at the main reservoir, as convenience requires.

Q. With the triplex governor, how can the change be made from the lower brake pipe pressure to the higher, when desired?

A. By closing the stop cock in the branch pipe leading from the main governor pipe connection to the low pressure governor top, just as in the "duplex high pressure control."

Q. Where is the advantage in having the third pressure top?

A. It permits of any desired excess pressure being accumulated in the main reservoir while the brakes are applied; and while brakes are released requires the pump to operate against the ordinary main reservoir pressure only.

Q. What are the advantages to be had from the use of the triplex governor when using "single pressure" system and with the triplex governor when using the "double pressure" system?

A. In a main reservoir of ordinary size a high pressure may be accumulated while brakes are applied, and when releasing brakes this pressure is very effective in causing the prompt and certain release of all brakes. Also, on account of the smaller main reservoir capacity and higher pressure, a much quicker recharging of all the auxiliary reservoirs in the train may be effected, which is a very desirable feature, especially in mountainous service.

NEW YORK AUTOMATIC BRAKE VALVE.

Q. What are the principal parts of the engineer's automatic brake valve?

A. The main slide valve and its seat, controlling the ports between the main reservoir and the brake pipe, and between the brake pipe and the atmosphere; the quadrant, the handle, handle shaft, and link for moving the main slide valve; the equalizing piston with valves and lever, and small cut-off valve for regulating the brake pipe reduction in service applications and for automatically closing the service opening; the excess pressure valve and spring for maintaining excess pressure in the

main reservoir; the body, and cover for enclosing these parts, and the supplementary reservoir.

Q. What are the air pipe connections to the brake valve and how many?

A. There is a main reservoir, brake pipe, pump governor, air gauge, red hand, and air gauge, black hand, connection, five in all.

Q. How many positions are there on the automatic brake valve for the handle?

A. Five.

Q. Name them.

A. Release, running, positive lap, service graduating, sub-divided into five notches, and emergency.

Q. How does the brake valve reduce the brake pipe pressure when it is desired to apply the brakes in service applications? In emergency applications?

A. The service exhaust port in main slide valve between the brake pipe and the atmosphere, is opened, by placing the handle in the service graduating notch, corresponding to the amount of reduction it is desired to make. Air from the brake pipe and chamber A can now escape through port F and G in slide valve and exhaust port C, in its seat, to the atmosphere. The graduating slide valve, operated by the equalizing piston and lever, gradually reduces the service port opening as the reduction in brake pipe pressure is being made, until it entirely closes or automatically laps port F. In emergency applications the main slide valve opens the brake pipe wide through the large ports J and K, making a quick, heavy reduction in pressure.

Q. In emergency application does the valve automatically lap itself?

A. No; when the handle of the brake valve is placed

in the emergency position a large direct opening is made between the brake pipe and the atmosphere, which will be closed only when the handle is moved to any one of the other positions.

Q. When making any kind of a brake application, is communication between the brake pipe and the main reservoir closed?

A. Yes; always by the main slide valve.

Q. In positive lap position are all ports closed?

A. Yes; all except port O.

Q. Where is main reservoir pressure found in the valve?

A. In chamber B on top of the main slide valve under the excess pressure valve, and in the pipe to the red hand of the air gauge.

Q. Where is brake pipe pressure found?

A. In chamber A; on the face of the main slide valve; on the brake pipe (chamber A) side of the equalizing piston; in the pipe to the black hand of the air gauge, and the pump governor cavity.

Q. Where is the supplementary reservoir pressure found?

A. In chamber D, between the equalizing piston and the back cap, in passages H to the supplementary reservoir and in the supplementary reservoir.

Q. How does air pass from the main reservoir through the engineer's brake valve into the brake pipe?

A. In full release position, it flows through a large, free opening in the valve seat, past the end of the main slide valve, and in running position, this direct passage being closed, it flows past the excess pressure valve which holds a definite amount of pressure in the main reservoir above that contained in the brake pipe, and through a

small opening or passage in the slide valve seat, and a cavity in the main slide valve into chamber A and the brake pipe.

Q. What takes place when the handle is placed in full release position, after a brake application?

A. Main reservoir air, as already explained, flows in large volume direct into the brake pipe, releasing the brakes and recharging the auxiliary reservoirs. At the same time a portion of the air in the supplementary reservoir and chamber D is discharged to the atmosphere. Main reservoir air also flows into passage E and the pump governor cavity, thence direct to the pump governor.

Q. Why is it necessary to discharge a small quantity of air from the supplementary reservoir and chamber D when the handle is moved to release position?

A. In order to permit brake pipe pressure in chamber A to force the piston to its normal position, where it should always be at the commencement of a service reduction.

Q. What takes place when the brake valve handle is placed in running position?

A. The large, free opening from the main reservoir to the brake pipe, past the end of the main slide valve, is closed, and governor cavity E is connected direct to the brake pipe through cavity M in the main slide valve. Main reservoir air then flows past the excess pressure valve, as already explained, into pump governor cavity E and brake pipe.

Q. What is the function of the excess pressure valve?

A. To maintain in the main reservoir, with the handle in running position, a predetermined pressure above that in the brake pipe. After this pressure has been accu-

mulated in the main reservoir, the excess pressure valve will unseat and permit air to flow into the brake pipe.

Q. What is excess pressure used for?

A. For releasing brakes promptly, and for quickly recharging auxiliary reservoirs.

Q. What is the positive lap position used for?

A. To blank all ports, excepting port O, between the atmosphere and the supplementary reservoir, and to prevent the flow of air in any direction through the valve.

Q. What valve controls or closes passage and port O, when the handle is in any position except service and emergency?

A. The vent valve.

Q. What occurs when the handle of the brake valve is placed in any one of the service graduating notches?

A. Communication is cut off between the main reservoir and the brake pipe; port O (the end in the main slide valve seat) is closed by the main slide valve; the brake pipe exhaust port F, in the main slide valve, is moved past the edge of the graduating slide valve so as to open this port. Brake pipe air then passes into ports and passage F and G, in the main slide valve and out through exhaust port C, in the slide valve seat, to the atmosphere. This reduction of brake pipe pressure in chamber A, on the brake pipe side of the equalizing piston allows the supplementary reservoir pressure in chamber D (equal to the initial brake pipe pressure before service brake pipe reduction began) to expand, and move the equalizing piston forward. This piston, by means of the connecting lever, then moves the graduating slide valve backward, on the face of the main slide valve until it gradually closes exhaust port F.

Q. After exhaust port F is thus closed, what occurs

if the brake handle is moved to the next graduating service notch?

A. The same as explained in the preceding answer.

Q. Why is port F, with the handle of the brake valve in the first service graduating notch, only half uncovered?

A. So that on trains consisting of four cars or less the initial reduction in brake pipe pressure, which should be made in this notch, will not be heavy enough to cause quick action of the triple valves. But with five or more cars any service graduating notch except the first may be used in making the initial reduction.

Q. How much pressure will be drawn from the brake pipe if all the service notches have been used?

A. From 23 to 25 pounds, the initial brake pipe pressure being 70 pounds.

Q. If all the service graduating notches on the engineer's brake valve are used, will the brakes be set in full service?

A. Yes; as a total service reduction of from 23 to 25 pounds will apply the brakes in full.

Q. If, after a service application has been made, either partial or full, an emergency should arise, where should the handle be placed?

A. In emergency position always.

Q. Of what benefit would this be?

A. If any brakes on the train had partially leaked off, thereby reducing their holding power, the additional reduction in brake pipe pressure would increase brake cylinder pressure and set them harder; those that were only partly set would be set in full.

Q. How does air escape from the brake pipe when the handle is placed in the emergency position?

A. The air is discharged direct from the brake pipe

through large exhaust ports J and K in the main slide valve, and exhaust port C, in the seat, to the atmosphere.

Q. Why are exhaust ports J and K made large?

A. So that in emergencies the reduction in brake pipe pressure may be made sufficiently quick and heavy to produce serial action of the triple valves.

Q. If upon making service application the graduating valve fails to lap automatically, what should be done?

A. Move the handle gradually back until brake pipe exhaust ceases, or to positive lap position, after the desired reduction in brake pipe pressure has been made.

Q. What is usually the cause of the graduating valve failing to lap automatically?

A. Leakage from the supplementary reservoir and its connections; also from chamber D through the back head gasket. Leakage past the piston packing leather and the packing ring will also cause the valve to fail to lap automatically.

Q. How can this leakage from chamber D and the supplementary reservoir be located?

A. If the leakage is to the atmosphere it may be found by coating the joints with soapsuds. If it is in the piston packing leather or ball check valve, after ascertaining that there is no leak in the main slide valve, move engineer's valve handle to emergency position, letting all air out of the brake pipe. If now the cut-out cock in the brake pipe beneath the brake valve be closed, and the handle placed in any service notch, a leak by the packing leather or the ball check valve from supplementary reservoir and chamber D will be manifest by the rising of the black hand of the duplex air gauge. With the handle left in emergency position it will be manifested by a blow at the exhaust port C.

Q. Should a more exacting test be desired, how should it be made?

A. By increasing brake pipe volume, making it equivalent to the volume found with a long train. Then operate the valve to be tested, in service application position, to ascertain if the valve will automatically close off. If the brake pipe discharge fails to close off entirely there is leakage at some point from the supplementary reservoir, its connections or chamber D, probably past the packing leather of the equalizing piston.

Q. What would cause leakage past the piston packing leather?

A. Packing leather improperly fitting the cylinder, being worn through by the expanding spring, or bottom of the cylinder cut by dirt accumulating there from the brake pipe.

Q. How could you test the main slide valve for leakage?

A. With the engine alone, by first moving the handle to emergency position and exhausting the brake pipe air, then returning the handle to positive lap position, exhausting the supplementary reservoir air, then closing the stop cock under the brake valve. With the reduced brake pipe volume any leak through the main slide valve will be quickly manifested by an increase of pressure in the brake pipe and chamber A, indicated by the rising of the black hand on the air gauge, or by a blow at the exhaust port C, or by both.

Q. How could you test the small cut-off valve for leakage?

A. Place the handle in the second service graduating notch, and after the automatic cut-off has taken place, close the cut-out cock under the brake valve. If a blow

is heard at the exhaust port, accompanied by a falling of the black hand on the air gauge, the cut-off valve is leaking.

CLEANING AND OILING.

Q. What parts of the valve require lubrication?

A. The main slide valve, the graduating slide valve, the equalizing piston, and the handle shaft.

Q. What is likely to be wrong if, after applying brakes on a train or while the brake valve handle is on lap, the governor stops the pump (where the single governor is used) and prevents the accumulation of excess pressure.

A. Leakage past the excess pressure valve will most likely be the cause, provided the small relief port in the pump governor is plugged up. With this relief port open excessive leakage past the excess pressure valve would prevent the pump from accumulating the excess pressure.

Q. How would you proceed to clean the excess pressure valve?

A. After closing the stop cock in the brake pipe below the brake valve, and drawing off all the main reservoir air, remove the cap of the excess pressure valve, take out the valve and rub it clean with a little kerosene oil, replacing it perfectly dry.

Q. When is the best time to clean the excess pressure valve?

A. Before starting the pump and before any pressure has accumulated in the main reservoir. All then that is necessary to do is simply unscrew the cap, clean the valve, and replace it dry.

Q. If with a long train and the brake valve handle in release position brake pipe pressure increases slowly, where should the trouble be looked for?

A. Lost motion on the inner end of the handle shaft, or in the link and pins in the main slide valve.

Q. What provision has been made to assist the engineer in finding the running position on the older style of valves, when the sharp point of the handle latch has been worn off?

A. A pin is set on the inside face of the quadrant, just below the running notch, by which the engineer may be guided to running position. On the later form, however, the quadrant has been modified so as to contain deeper notches.

Q. For what purpose are the two brass plugs in the cover of the automatic brake valve?

A. To enable the engineer or air brake inspectors to oil the main slide valve without taking the brake valve apart.

Q. When and how should the main slide valve be oiled?

A. The best time to oil the valve is before starting the air pump, and when there is no pressure in the main reservoir; when this is the case remove both brass plugs, place the handle in full release position and pour a few drops of good oil through the hole back of the main slide valve, then place the handle in emergency position, and pour a few drops through the hole in front of the main slide valve, replace the brass plugs and work the handle back and forth a few times to spread the oil over the seat. The slide valve should receive a little oil through the oil plugs only when it commences to work harder than usual. Don't pour in too much oil; it will only serve to gum up the working parts.

Q. Suppose there is pressure in the main reservoir and it is desired to oil the main slide valve?

A. Then take the same steps as would be necessary to clean the excess pressure valve. Close the stop cock in the brake pipe, under the brake valve, stop the pump and exhaust the air from the main reservoir, when the oil plugs may be removed for oiling the slide valve, and the excess pressure valve may be removed for cleaning. However, the best time to do this work is before the pump has been started and before commencing the trip.

LEAKS AND OTHER DISORDERS.

Q. Will an ordinary leak in the main slide valve release the brakes?

A. No; with an ordinary leak from the main reservoir through the main slide valve during the time of application of the brakes, air will be going out to the atmosphere along with the brake pipe air and, as the main reservoir leak will augment the brake pipe pressure in front of the equalizing discharge piston somewhat, the graduating slide valve will hold the service port in the main slide valve open sufficiently to accommodate the main reservoir leak, and thus prevent increase of brake pipe pressure sufficient to release brakes.

Q. Suppose such a leak exists and the handle is moved back to positive lap position, after a service reduction, what will be the effect?

A. The brake will probably release, especially if the train is a short one.

Q. If a continuous blow of air is heard at the main exhaust port when the handle is in release, running or positive lap position, where would the trouble likely be found?

A. The vent valve on the end of the graduating valve is probably leaking.

Q. In applying new leathers to the equalizing pistion what precautions should be taken?

A. The piston should be removed from the cylinder and all parts cleaned with kerosene. Care should be taken not to bend or kink the coil spring expander as, if this is done, the tendency will be for the expander on account of being distorted, to cut the leather.

Q. If the copper pipe between the brake valve and the supplementary reservoir be broken off on the road, could the train be handled satisfactorily with the brake valve?

A. Yes; it could be handled satisfactorily.

Q. In what manner?

A. By plugging the connection at the brake valve of this pipe, and by making the required brake pipe reduction in the first or second graduating notch, depending on the length of the train, and moving the handle slowly to positive lap position when this is done. As the brake pipe and gauge is connected to chamber A, it shows the actual brake pipe pressure in all positions of the brake valve handle, and the engineer will have no difficulty in controlling the flow of air from the brake pipe without danger of an emergency, or of making an insufficient reduction.

Q. Will the brake valve reduce pressure in service applications and automatically lap the valve, as it should, if any other initial brake pipe pressure than 70 pounds be used?

A. Yes; if the brake pipe pressure be carried to 90 or 110 pounds and the handle of the brake valve be placed in the last service graduating notch, a reduction in pressure sufficient to equalize the auxiliary reservoir and brake cylinder pressure will be had before the valve automatically laps.

Q. What are the reductions made at the brake valve corresponding to the different notches when the brake pipe pressure is 90 pounds? When 110 pounds?

A.	70 lbs.	90 lbs.	110 lbs.
1st Service Graduating Notch	5-5	5-5	6-6
2nd " " "	8-3	9-4	10-4
3rd " " "	11-3	13-4	14-4
4th " " "	16-5	19-6	21-7
5th " " "	23-7	27-8	30-9

Q. Will these reductions in each case fully equalize the auxiliary and the brake cylinder pressures?

A. Yes; from 70 pounds a reduction of 23 pounds will allow the brake to set in full; from 90 pounds a reduction of 27 pounds will allow it to be set in full, and from 110 pounds, provided there are no reducing valves on the brake cylinder, a brake pipe reduction of 30 pounds will set the brake in full.

Q. When the handle of the brake valve is moved to any one of the service graduating notches, is air allowed to escape direct from the brake pipe?

A. Yes; brake pipe reductions are always made direct from the brake pipe with this valve.

Q. In making water tank stops, and in fact all station stops, with high speed trains how should the brake valve be handled?

A. By the two application method.

QUESTIONS AND ANSWERS—NEW YORK TRIPLE VALVE.

PLAIN TRIPLE—STYLES A, C, AND E.

Q. What are the essential parts of the plain triple valve?

A. The triple piston valve, the exhaust slide valve, and the graduating slide valve.

Q. What are the pipe connections to the plain triple valve?

A. Brake pipe, auxiliary reservoir, and brake cylinder.

Q. What are the functions of the operating parts?

A. The exhaust slide valve controls the exhaust of air from the brake cylinder to the atmosphere, to release brakes; and the graduating valve controls the admission of air from the auxiliary reservoir to the brake cylinder, to apply the brakes. The triple piston moves the exhaust valve and the graduating valve, when brake pipe pressure is reduced below auxiliary reservoir pressure, so that the exhaust valve will close the exhaust port, in its seat, before the graduating valve opens the service port, in its seat, leading to the brake cylinder. The slide valve remains stationary after once reaching application position, while the piston in partial service applications (brake pipe reductions of less than 20 pounds), returns part way, and causes graduating valve to cover, or lap, the service port.

Q. How does the air pass through the triple to charge the auxiliary reservoir?

A. Air from the brake pipe passes to the cylinder and chamber on the plain side of the piston, then through a

small charging groove shown in the top of bushing and passage on the shoulder of the piston, to the chamber on the slide valve side of piston, thence into the auxiliary reservoir, until the latter is charged up equal to the brake pipe.

Q. What causes a brake application with the plain triple?

A. A reduction of brake pipe pressure which makes that pressure less than the auxiliary reservoir pressure.

Q. Explain the operation of the plain triple in a brake application.

A. When the brake pipe pressure is reduced below that in the auxiliary, the piston moves its full stroke, first cutting off the communication between the auxiliary reservoir and the brake pipe through the charging grooves in the top of its bushing, then moving the exhaust valve and the graduating valve to application position, covering the exhaust port and opening the service, or graduating, port. This movement of the triple piston, and the position of the slide valves allow reservoir air to enter the brake cylinder, the quantity admitted being in proportion to the brake pipe reduction. If the brake pipe pressure is reduced but little, the pressure in the reservoir is soon reduced, by expansion, into the brake cylinder, to slightly less than that in the brake pipe, when the piston starts back and carries graduating valve to lap position, closing the service port, without disturbing the exhaust valve and cutting off further flow of auxiliary air to the brake cylinder. The exhaust valve is held to its seat with some force by the air pressure on top of it, aided by the spring, and checks the return stroke when graduating valve has closed the service port.

Q. Should an increased or full application of the brake be desired, how could it be had?

A. A further reduction of brake pipe pressure repeats the same action of the triple piston and the graduating valve, and applies the brakes a little harder. If the brake pipe pressure is reduced 5 to 8 pounds, the brakes will be applied with but moderate force; if, however, the brake pipe pressure is reduced 20 pounds or a trifle more, the graduating valve will remain open and the brakes go full on, as the auxiliary reservoir pressure will then continue to flow into the brake cylinder until the pressure in both is equalized.

Q. How is the brake released?

A. An increase in brake pipe pressure, over that in the auxiliary, will cause the triple piston and the slide valves to move back to normal position, where the exhaust valve uncovers the exhaust port to the atmosphere, releasing the brakes, and allowing the reservoii to be recharged.

Q. For what purpose is the small chamber?

A. To allow moisture from the brake pipe to collect in this chamber, where it can be readily drained away by unscrewing the plug.

Q. What oil is recommended for lubricating the plain triple?

A. After cleaning, the triple valve requires hardly any oil, just enough to dim the surface of the slide valves and seats, and the piston and the cylinder surrounding it. Vaseline is excellent when used in this way. The oil used, however, should be one that will not gum

Q. Why is there no graduating spring in this triple valve?

A. The piston and the slide valves have the same stroke

for both service and emergency applications, thus making a graduating spring unnecessary.

Q. Suppose the triple valve while in use on an engine or tender should become defective, how could it be cut out?

A. By closing the stop-cock in the branch or cross-over pipe put there for that purpose.

Q. Is the plain triple valve, style A, intended for use on cars?

A. No; it is intended for use only on engines and tenders in conjunction with 6-inch and 8-inch brake cylinders.

Q. If the exhaust valve should leak how can it be detected?

A. By a blow from the exhaust port of the triple, both while the valve is in release and in application positions.

Q. Should graduating valve leak how can it be detected?

A. By a blow from the exhaust port of the triple while the valve is in release position, which ceases when it is in application position; and in partial service applications possibly by the brake releasing without increase of brake pipe pressure.

Q. What size auxiliary reservoir should be used with style A triple valve?

A. A 10-inch by 24-inch auxiliary reservoir should be used with this triple in connection with 6-inch driver brake cylinders, and 6-inch and 8-inch tender and engine truck brake cylinders.

Q. For what is the style C plain triple valve intended?

A. For use with 12-inch and 14-inch tender brake cylinders, and for use with 12-inch, 14-inch and 16-inch

driver brake cylinders, operated either separately or in combination with the engine truck cylinders.

Q. How may the style C plain triple valve be distinguished from the earlier plain triples?

A. A three-quarter inch pipe is necessary to use with this triple to allow the air to flow freely enough to the larger brake cylinders with which it is used. One-half-inch pipe is not large enough.

Q. What is the principal difference in the interior construction of style C and style E triple valves?

A. The triple piston in style C triple is larger in diameter than that in style E.

Q. For what service is the plain triple valve style E intended?

A. For use with 6-inch, 8-inch and 10-inch tender cylinders and driver brake cylinders, operated either separately or in conjunction with engine truck brake cylinder.

Q. What size of pipe is necessary with this triple valve?

A. Three-quarter-inch pipe is necessary, the same as with the style C plain triple.

Q. Is the operation of the plain triple valves, styles C and E, the same as that of style A?

A. The method of charging the auxiliary reservoir is the same, and the principle of operation is the same. However, the construction of the triples is different, in that the graduating valves are of the poppet or check valve variety instead of the slide valve type, and the triple pistons have a double stroke.

Q. Why do these triple valves have a double stroke?

A. In service applications the triple piston moves over only a portion of its stroke, bringing the small service

port in the slide valve opposite the port in its seat leading to the brake cylinder. In emergency applications it moves its full stroke, and the slide valve uncovers the whole of the brake cylinder port, thus permitting a very quick and full equalization of pressure to take place between the auxiliaries and the brake cylinders.

Q. For what purpose is the graduating spring?

A. In service applications it prevents the triple piston from moving too far, and applying the brakes in emergency.

NEW YORK QUICK ACTION TRIPLE VALVE.

Q. Name the principal operative parts of the New York quick action triple.

A. Main triple piston, exhaust slide valve, graduating slide valve, the vent piston, emergency piston, a rubber seated vent valve, a rubber seated quick action valve, and a non-return brake cylinder check valve.

Q. The plain triple valves have the triple piston, the exhaust valve and the graduating valve. Why are the additional valves placed in the quick action valves?

A. So that in emergency applications the triple may vent the brake pipe locally and at the same time cause quick equalization of auxiliary and brake cylinder pressures.

Q. Why is it necessary to vent brake pipe air to the atmosphere?

A. To produce a quick, serial action of all the quick action triple valves throughout the train, thus getting the brakes on the whole train quickly.

Q. Is any greater pressure obtained in the brake cylinder in an emergency application than in a full service?

A. No; as this triple valve uses auxiliary reservoir air

alone in both service and emergency applications, no higher maximum brake cylinder pressure is obtained in one kind of application than in the other. In service the brakes apply gradually; in emergency they apply almost instantly with the full cylinder pressure.

Q. Why is this triple valve called a quick action triple?

A. For the reason that in emergency applications it carries the auxiliary air to the brake cylinder almost instantly to the full equalized pressure.

Q. How does venting of brake pipe air at the triple produce quick serial action throughout the train?

A. Brake pipe pressure, in an emergency application, is first quickly vented at the engineer's brake valve; this sudden venting actuates the quick action parts in the quick action triple valve on the car next to the engine. This quick action triple then vents brake pipe air to the atmosphere, and the venting at this triple actuates the quick action parts in the quick action triple on the next car, causing it to vent brake pipe air to the atmosphere, and so on throughout the train.

Q. Explain the operation of this quick action triple.

A. The exhaust valve and graduating slide valve cover the exhaust and the service graduating ports, and these valves are moved by the main piston to apply and to release the brakes in the usual manner. (See Plain Triple C and A.) Thus it will be seen that in the quick action triple valve, piston, exhaust valve and graduating slide valve alone are used in making service applications, and its operation in these applications is precisely the same as that of the plain triple valve.

Q. Name the quick action parts of the triple valve.

A. They are the vent valve piston, the vent valve, the

plain (quick action) piston, the quick action valve, and the brake cylinder check valve.

Q. Do these parts operate in a service application?

A. No; in service applications these parts remain inoperative, but in emergency applications they are called into action. Vent valve is held to its seat by spring, assisted by brake pipe pressure, and is opened by piston when that piston is forced to the left. Quick action valve is held to its seat by spring, assisted by auxiliary reservoir pressure, and can only be opened when quick action piston moves to the right.

Q. How does the quick action triple operate in service applications? How in energency applications?

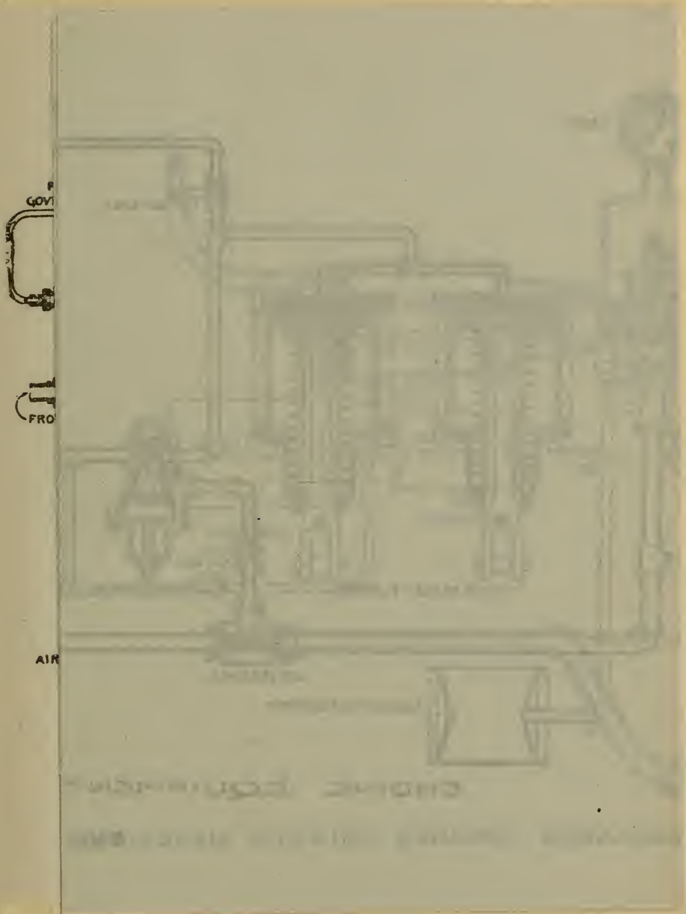
A. Main piston has the same stroke for both service and emergency applications, and is extended to form a cylinder in which the vent piston is fitted.

Q. Will the vent valve stand open and exhaust all brake pipe air?

A. No; since port F is always open the momentary excess pressure exerted on the piston will quickly equalize with the brake pipe pressure, and the spring, together with the brake pipe pressure, will return the vent valve to its seat, thus stopping the escape of air when brake pipe pressure is sufficiently reduced to apply the brakes with full force. As the vent valve closes it returns the piston to its normal position, its travel in that direction being limited by the stop. Valve and piston, after equalization has been effected in the brake cylinder, will return to their normal positions.

Q. How does the valve release the brakes?

A. Increasing the brake pipe pressure until it is greater than that in the auxiliary reservoir causes the main piston and with it the slide valves, to return to their normal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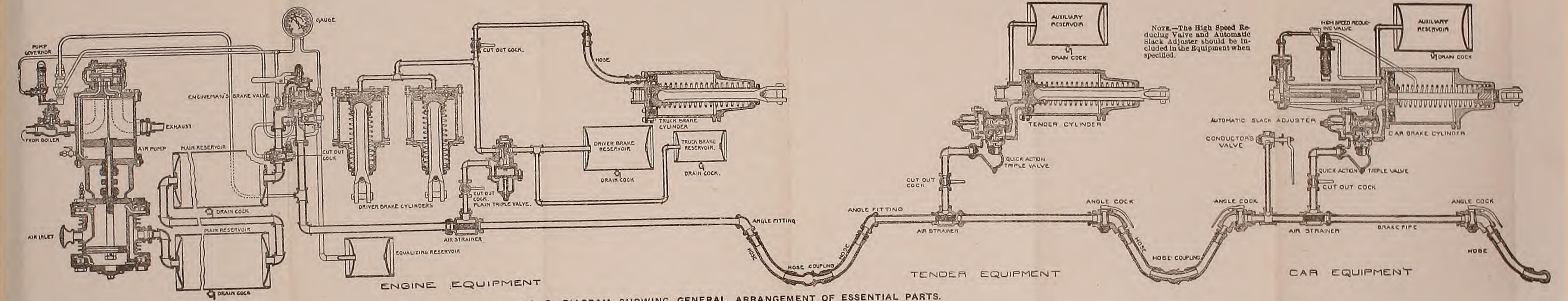


FIG. 5.—DIAGRAM SHOWING GENERAL ARRANGEMENT OF ESSENTIAL PARTS.

(release) positions, closing the service port and allowing the auxiliary reservoir to recharge through the feed groove, and at the same time the air in the brake cylinder to escape into the atmosphere through the exhaust cavity in slide valve, and the exhaust port in its seat.

DISORDERS AND REMEDIES.

Q. What would happen if the cap nut were not securely tightened, or the emergency valve leaked?

A. It would leak away auxiliary reservoir air the same as a slightly opened release valve, and if fast enough, cause the brake to release.

Q. Suppose the check valve leaked or the cap nut were not securely tightened and leaked?

A. Brake cylinder air would leak away and the braking force would reduce the same as with a leaky piston packing leather.

Q. Although it is not necessary to disconnect the brake pipe to clean the operative parts of the triple, is it not advisable to disconnect, inspect and clean the triple valve strainer?

A. Yes; the improved drain cup and brake pipe strainer has largely reduced the amount of dirt that usually finds its way to the triple valve but does not entirely exclude it.

Q. Describe this improved brake pipe strainer.

A. The strainer is mounted on a removable spider and may be removed without breaking the pipe joints, for the purpose of examination. The strainer is placed at the top where no water or dirt rolling along in the pipe can reach it. The drainage pocket may be emptied by unscrewing the plug.

Q. Is it not highly essential that dirt should be excluded as far as possible from the triple?

A. Yes; dirt causes the packing rings to stick in their cylinders, and sometimes lodges on the vent valve, causing it to stick. To prevent these troubles as far as possible the strainer should be taken out and cleaned occasionally, and also the strainer in the brake pipe drain cup.

Q. Where would you look for trouble if there was a constant flow of air out of port J in the side of the triple valve?

A. A blow at port J indicates that the vent valve is leaking, or accompanied sometimes by a blow at the exhaust port of the triple valve indicates that the quick action or emergency valve is leaking. Occasionally the quick action valve is held from its seat by the quick action piston cylinder, which prevents that piston from returning properly. If it is the vent valve that is leaking it will be indicated by the application of the brake when the cut-out cock in the branch pipe is closed.

Q. If, while the air pump labored hard, brake pipe pressure continued to fall and brakes could not be properly released, indicating that there was a bad leak in the brake pipe somewhere, where would you look for the trouble?

A. Examine hose connections and brake pipe connections proper and listen for leaks at port J of the triple valve.

Q. How could the particular triple or triples giving the trouble be located?

A. By blowing or leakage of pressure at port J.

Q. Where would this leakage be coming from, and what defective parts would cause it?

A. The leakage would be coming direct from the

brake pipe, through vent valve on account of it not being seated properly, or the rubber seat being defective.

Q. What causes would prevent the vent valve from seating properly and securely?

A. First, there might be some dirt or other foreign matter lodged between the valve and its seat. Second, a too tight fit of the packing ring in vent piston due to poor repair work, or dirty and gummy cylinder. Third, bent vent piston stem, caused by repairman or cleaner wrenching the valve apart or forcing it together, which holds the vent valve off its seat. Fourth, stop plate taken off during cleaning and put back out of line, binding the piston and holding the vent valve partly open. Fifth, in the older triples, the rubber seat of the vent valve, becoming worn at the bottom, will allow the lever arm of the vent valve and the stem of the vent piston to come in contact, thus leaving an opening past the worn seat for brake pipe pressure to escape. This does not occur with the improved vent valve.

Q. Suppose the pump labors hard and brakes refuse to release, and while search is being made to locate the cause of the trouble, it corrects itself and disappears. Where should we look for the trouble?

A. The vent piston is probably gummed up and for this reason is allowing vent valve to return to its seat gradually, and while doing so to discharge brake pipe air to the atmosphere via passage H and port J, the leakage ceasing when the vent valve finally seats. When this disorder is located the triple should be put in order, or should be cut out.

Q. If a quick reduction be made in brake pipe pressure and the quick action parts of the triple do not respond properly, where should the trouble be looked for?

A. Port F should be examined to determine whether it has been enlarged in size or not, and the packing ring in the vent valve piston should be examined for leakage. Port F enlarged beyond standard size and excessive leakage past the piston ring would permit chamber G pressure to reduce almost uniformly with that in the brake pipe and possibly prevent the operation of the quick action parts.

Q. Are the New York and the Westinghouse quick action triples interchangeable?

A. The one will fit on the cylinder and auxiliary reservoir of the other, but the internal working parts of one will not fit into the body of the other.

Q. If, in a train of mixed New York and Westinghouse triples, a brake works in quick action with a service application, can it be told whether the defective triple valve is a New York or a Westinghouse?

A. It can in many cases; a New York triple that works in quick action, when making a service application, usually does so with less than a five-pound reduction; while a Westinghouse in same condition, usually requires a five-pound service reduction to apply it in quick action, and sometimes more.

Q. How can a defective triple valve be located?

A. By stationing the trainmen along the train and noting which valve, in a service application, vents air to the atmosphere. If the ground is dry the defective triple can be located by the dust that will be stirred up by the vented air. Another method is to close an angle cock about the middle of the train and have an application made to determine whether it is in front, or back of this point, proceeding in this manner until located. In cases where quick action occurs during a service reduction, the

length of service reduction had at the brake valve before it suddenly terminates the service reduction, is an indication of the location of the point in the train at which the defective triple is located.

Q. What is the object of the small plug in vent piston?

A. To permit of easily grinding in the vent piston ring; a ¼-inch hole is drilled through the piston, which gives a free passage of air to and from chamber G during the process of grinding. After the ring has been fitted the plug referred to is inserted.

Q. Formerly port F was located in the vent piston. What improvement in the action of the triple is had from the present location of port F in the piston stem?

A. In emergency applications the vent valve piston stem is carried to the left, and port F in this stem is carried into the bushing in the vent valve seat, the bushing being made a close fit around the stem, so that the escape of air from chamber G is considerably retarded. This prolonged retardation of the escape of air from chamber G causes the vent piston to hold the vent valve from its seat longer, and thus to vent more of the brake pipe air to chamber H. The increased quantity of brake pipe air vented to chamber H has the effect, after forcing over the quick action piston, of holding it there longer, which results in holding the quick action valve off its seat longer; and the effect of the combined action is to cause an almost instantaneous equalization of pressure between the brake cylinder and the auxiliary reservoir, and a quicker serial application.

Q. What other effect is produced in the operation of the triple valves by the present form of port F?

A. It enables quick action to jump a greater number of plain triple valves placed together in succession or a

greater number of cut-out quick action triple valves in succession than formerly. Also it provides for a sufficient venting of air from the longer train pipes found on modern cars, and insures a sufficient reduction to produce serial quick action throughout the whole train.

Q. What is the function of the port and passage leading from port J in front of the piston to the rear of this piston, then back under the bushing to port J again?

A. To relieve the cushioning effect which would be had due to the quick movement of this piston, and to enable the vented train pipe to hold it over the required period of time.

Q. Can the present vent piston, having port F drilled through the stem, be substituted in the older triples and produce the same effect in quick action as is had in the modified triple?

A. Yes; and this is done when the older triples come in for cleaning and repairs.

Q. With the exception of the above, is the operation of the present quick action triple and the older triples the same?

A. Yes; and all the answers given to the questions relative to the present form, with the exception of those given below, apply to the older style.

IMPROVED QUICK ACTION PASSENGER TRIPLE, STYLE S-1.

Q. In what does the style S-1 passenger quick action triple differ from the standard quick action triple?

A. It is larger, has a larger service graduating port for the air to pass through to the brake cylinder, also a larger exhaust port; the exhaust valve has a service graduating port drilled through it, and carries the graduating valve mounted on top.

Q. What advantage is there in placing the graduating valve on top of the exhaust valve?

A. It reduces the friction of the moving parts. When the triple piston begins to move, the graduating valve is moved first to uncover the service port in the exhaust valve; then the exhaust valve is moved until the graduating ports in the exhaust valve and its seat come in register. In this style of triple but one slide valve is moved at a time.

Q. Should the graduating valve in the style S-1 quick action passenger triple leak, how could it be detected?

A. By making a partial service application, and then noting whether the brake released of its own accord or not.

Q. If the graduating valve in this triple leaks will it allow air to escape through the exhaust port while in release position?

A. No; when the exhaust valve is in release position it controls the opening from the auxiliary to the brake cylinder and atmosphere, and no air leaking by the graduating valve can escape through this port.

Q. With what size brake cylinders are the style S-1 quick action triple valves used?

A. With 12, 14 and 16-inch brake cylinders.

Q. How may this triple valve be distinguished from the freight and 10-inch passenger triple valve?

A. The letter S is cast on the triple valve and it fastens to the brake cylinder with three studs.

Q. How may the parts of this triple that are not interchangeable with similar ones of the other triples be distinguished?

A. The letter S is stamped on the parts that are not interchangeable.

Q. Is there any difference in the side cap of the style S-1 and P-1 and the freight triple valves?

A. Yes; the side cap of the triples S-1 and P-1 are tapped out for ½-inch pipe and a pipe plug inserted.

Q. Why is this side cap tapped out for ½-inch pipe?

A. To permit of the attachment of the compensating valve for high speed braking.

Q. The drawings show the brake cylinder check valve made of metal (brass). What is the latest practice in connection with this valve?

A. The brake cylinder check valve is now made with a rubber seat in all styles of quick action triples, and will interchange with quick action valves.

QUICK ACTION TRIPLE, STYLE H-1.

Q. For what is style H-1 triple valve intended?

A. For use on 10-inch freight car equipment.

Q. How may this triple valve be distinguished from other forms of triple valves?

A. The letter H is cast on the side of the triple, and it fastens to the auxiliary reservoir with three studs.

Q. What triple is the style H-1 similar to in appearance and construction?

A. The appearance and construction of this triple is similar in many respects to the style S-1.

Q. As the style S-1 triple fastens to the auxiliary reservoir with the same number of studs as the style H-1, is it possible to get these triples on the wrong size brake cylinder?

A. No; while both these triples fasten with three studs the spacing of the holes is different.

Q. How can the parts of this triple that are not interchangeable be distinguished?

A. The letter H is stamped on the parts that are not interchangeable.

QUICK ACTION TRIPLE, STYLE P-1.

Q. For what use is the style P-1 triple valve intended?

A. For use on 10-inch passenger and tender cylinders.

Q. How can this triple valve be distinguished from style F triple valve which is for freight car use?

A. The letter P is cast on the side of this triple valve.

Q. In what points does this triple valve differ from the freight triple valve?

A. The feed grooves in the main piston bushing, and in the piston are larger. The vent port F in the vent piston stem is also larger.

Q. What parts of this triple valve are not interchangeable with the freight triple valve?

A. The main piston and the vent piston.

Q. How may the parts of this triple valve that are not interchangeable with the freight triple valve be distinguished?

A. The parts that are not interchangeable have the letter P stamped on them.

Q. Is there any difference in the operation of this triple from that of the others?

A. No; its operation is the same as that of the others.

Q. Is its side cap tapped out for the piping of the compensating valve?

A. Yes; compensating valves are used on all sizes of passenger triples.

QUESTIONS AND ANSWERS.

THE NEW YORK COMBINED AUTOMATIC AND STRAIGHT AIR BRAKE.

Q. What is the combined automatic and straight air brake?

A. It is a combination, upon the engine and the tender, of an automatic and a straight air brake, so that either of them may be operated separately at the desire of the engineer.

Q. Why was it necessary to combine the straight air brake with the automatic air brake on engines and tenders?

A. Because it was found that in switching service the straight air brake was more satisfactory than the automatic, and would give much better results; that in road service, in slowing up long freight trains, bunching the slack preparatory to a stop with the automatic, and holding trains bunched when releasing the automatic brake, as well as in controlling the speed of trains down long grades, it was an efficient aid.

Q. In addition to the usual automatic air brake parts on the engine and tender, what straight air brake parts are necessary to produce the combined apparatus?

A. There is required one ¾-inch straight air brake valve, style C; one straight air pressure reducing valve, two double throw check valves, and two safety valves with hand release; one each for the driver and the tender brake cylinder; one hose connection and union, with

angle fittings, and the necessary stop cocks, cut-out cocks and piping.

Q. What are the functions of the straight air brake valve?

A. With this valve, air is admitted to and exhausted from the brake cylinders in applying and in releasing the brakes.

Q. How many positions are there on the straight air brake valve for the handle?

A. Four; the release, lap, service and emergency application positions.

Q. How can these positions be told?

A. By means of the notches made upon the quadrant and the stops at each end.

Q. What is the type of air valve, in the engineer's straight air brake valve, that controls the flow of air between the main reservoir, brake cylinder and atmosphere?

A. It is an ordinary D slide valve.

Q. Should this valve ever become dry and hard to operate, how could it be lubricated?

A. By first closing stop cock in the main reservoir pipe and working the handle back and forth a few times to exhaust the air from the brake valve; then by removing the oil plugs in the cover; the slide valve and its seat may then be lubricated.

Q. What is the function of the straight air brake pressure reducing valve?

A. The straight air brake pressure reducing valve, limits the pressure obtainable in the straight air brake pipe and in the brake cylinder to the desired amount.

Q. At what pressure does the reducing valve usually limit the air for the straight air brake?

A. Usually at 45 pounds, but this may be varied to suit special conditions, and the valve may be set to furnish either more or less.

Q. How is the straight air pressure reducing valve adjusted?

A. By removing the cap nut and screwing the regulating screw to increase the pressure, and by unscrewing it to reduce the pressure.

Q. Why are the spring case, the regulating spring, and regulating nut located above the supply valve?

A. To prevent moisture, dirt and oil coming from the main reservoir from lodging upon the rubber diaphragm, which constitutes the wall between the straight air brake pipe pressure and the regulating spring.

Q. What is the duty of the regulating spring?

A. Its duty is to keep diaphragm stem in position to hold the supply valve away from its seat until the brake cylinder pressure reaches the limit of its adjustment.

Q. Should the reducing valve leak, what would be the result?

A. Main reservoir pressure would then be had in the main reservoir pipe as far as the straight air brake valve, and in case of a straight air brake application, the leak would continue to raise the pressure in the brake cylinders until the relief valves opened.

Q. How can the supply valves be cleaned?

A. By closing the cut-out cock between the main reservoir and the pressure reducing valve and unscrewing the cap nut. The supply valve may then be removed and cleaned.

Q. How should the supply valve be cleaned?

A. By softening up the gum or dirt with a little kero-

sene or other light oil that will cut it, then wiping it perfectly clean.

Q. Should the supply valve be oiled when placed back in position?

A. No; it should be replaced perfectly dry.

Q. Should care be used about screwing up the spring case against the body?

A. Yes; care should be taken, when renewing the diaphragms and in replacing the spring case, not to screw the latter up so tight as to crush the diaphragms. A little space should always be left between the spring case and the body.

Q. How many sizes of double throw check valves are there?

A. Two.

Q. What are the sizes and why are two needed?

A. One is for ½-inch pipe connections and is for use with the smaller plain triples; the other is for ¾-inch pipe connections and is for use with quick action triple valves and the larger plain triples.

Q. Describe the double throw check valve.

A. It is a check valve of the piston variety with two faces, each having a leather washer or seat.

Q. What are the duties of the double throw check valves?

A. To close the communication between the triple valve and the brake cylinder, when the straight air brake is being used; and to close the communication between the straight air brake pipe and the brake cylinder, when the automatic brake is being used.

Q. How does the double throw check valve operate to close the communication between the triple valve, or

the straight air brake pipe, and the brake cylinder, when either brake is being operated?

A. If the straight air brake is being used, air is admitted to the straight air brake pipe, and the pressure will force the double check valve to the right, provided there be no pressure other than atmospheric on the other side of it, causing the leather seat on the triple connection end to seat air tight against the cap; the check valve will thus close the communication between the triple and the brake cylinder, and at the same time will open the ports in the check valve bush leading from the straight air brake pipe to the brake cylinder, in this manner establishing a communication between the straight air brake valve and the brake cylinder.

If it is the automatic brake that is being used, when air passes from the triple valve to the pipe leading to the brake cylinder the air pressure will force the double throw check to the left, and close the communication between the straight air brake pipe and the brake cylinder, and open the communication between the triple valve and the brake cylinder.

Q. Why are safety valves placed in the brake cylinders?

A. For the purpose of relieving the cylinders of any overpressure that might accumulate in them because of leaks from the straight air pressure reducing valve, the double throw check valve, or from an emergency application of the automatic brake while the straight air brake is applied.

Q. Why are these safety valves supplied with a hand release?

A. In order that there may be a double protection against wheel sliding, and so that on slippery or bad rail,

should the wheels slide, the engineer may quickly relieve the pressure sufficiently to start them rotating again. Also to prevent overheating of tires on long down grades.

Q. Should both the automatic and the straight air brake ordinarily be kept cut in ready for use at all times?

A. Yes; unless failure of some part requires cutting one or the other out.

Q. Should an excess pressure always be kept in the main reservoir?

A. Yes; to insure the satisfactory operation of the brake and a certain release at all times, an excess pressure of 10 or more pounds should be maintained in the main reservoir.

Q. In what position should the handle of the straight air brake valve be kept while the automatic brake is being used?

A. When using the automatic brake be sure that the handle of the straight air brake valve is in release position.

Q. What might happen if the handle of the straight air brake was in lap position while the automatic brake was being released?

A. There would be a likelihood of the driver and the tender brakes sticking.

Q. Should the automatic brake be used while the straight air brake is applied?

A. Ordinarily the straight air brake should be released before the automatic brake is applied, but in cases of emergency occurring after the straight air is applied no attention should be paid to this instruction, but apply the automatic brake in emergency immediately.

Q. Where should the handle of the automatic brake

valve be carried while the straight air brake is being used?

A. In the running position.

Q. Why should the handle of the automatic brake valve be carried in the running position while the straight air brake is being used?

A. For the same reason that the straight air brake valve handle should be carried in full release while the automatic brake valve is being used; that is, to avoid sticking of the driver and the tender brakes when it is desired to release them.

Q. Why are the driver and the tender brakes likely to stick unless the brake valve handles are carried as directed above?

A. In the case of using the automatic brake, while the straight air brake valve handle is on lap, leakage of air from the brake cylinder, or past the seat of the straight air brake valve as far as the seat of the double throw check valve will charge the straight air brake pipe with pressure; then. when releasing the automatic brake, as soon as the cylinder pressure has reduced below that the straight air brake pipe contains, the double throw check will shift its position and open communication between the straight air brake valve and the brake cylinder, and thus hold the brake applied with the remaining cylinder pressure, augmented somewhat by the higher pressure in the straight air brake pipe.

Q. Should care be used in handling the straight air brake?

A. Yes; as the straight air brake is nearly as powerful as the automatic on the engine and tender, it should be handled with judgment and skill. Care should be taken to avoid rough handling of trains with it, as it

must be remembered that the braking power is all on the engine and tender.

When using the straight air brake to steady trains on long down grades care should be taken to avoid loosening the tires on the drivers, from overheating them. This can be done by alternating the straight air on the drivers and the automatic on the train.

Q. When the safety valves that are placed in the brake cylinders operate in a full application of the straight air brake, what does it indicate?

A. Either the safety valves or the special straight air brake pressure reducing valve is out of adjustment or is leaking, and that these parts should be tested and adjusted at once.

Q. What is the best location for the brake cylinder safety valves?

A. It is better to have them piped up to the cab so that the hand release with which they are provided can be operated by the engine crew, whenever it is desirable to do so, to avoid wheel sliding or overheating of tires.

Q. How should the double throw check valve be tested for leakage?

A. With the handle of the automatic brake valve in running position, and the triple valve in release position, apply the straight air brake; should there be any leakage past the double throw check valve from the brake cylinder it will appear at the exhaust port of the triple valve in the form of a blow.

Having tested with the straight air brake valve in this way for leakage past one seat, next place the handle of the straight air brake valve in full release position and apply the automatic brake; any leakage past the other seat will appear at the exhaust port of the straight air

brake valve. When making this latter test, however, it should be known that the slide valve itself, of the straight air brake valve, is tight.

Q. If the automatic brake is partially applied, and straight air is then used, what will be the result?

A. In this case brake cylinder pressure will not be raised above that at which the pressure reducing valve is set.

Q. Where is the straight air brake valve located?

A. In the cab; usually on the side, in the most convenient place for operating.

Q. Whereabouts on the engine is the straight air brake pressure reducing valve usually located?

A. At some convenient point in the cab, where there is little or no danger of its freezing, and not too close to the boiler head, where it might possibly become overheated.

Q. How may errors in piping the straight air brake valve be avoided?

A. By noting that the main reservoir connection be made at that part of the brake valve that is marked in raised letters "Front." The brake pipe connection is made to the other connection, and in this brake pipe connection there is a hole drilled and tapped for the air gauge pipe.

Q. How would you test for a leaky slide valve in the straight air valve?

A. With the brake released, and the handle in full release position; if a blow is heard at the exhaust port the slide valve is leaking.

Q. What effect does a leak through the slide valve of the brake valve have upon the operation of the straight air brake?

A. Ordinarily during the time that a straight air brake application is held applied, if the leak is from the main reservoir pressure, the brake cylinder pressure will increase to the limit of the pressure reducing valve; but it might happen that the leak be from the brake cylinder to the atmosphere, in which event it would reduce the brake cylinder pressure.

NEW YORK HIGH SPEED BRAKE.

Q. Of what does the high speed brake consist essentially?

A. A brake pipe pressure of from 100 to 110 pounds, a compensating valve for each brake cylinder, a triplex pump governor, and the ordinary quick action mechanism.

Q. In what class of passenger service is the high speed brake used?

A. In modern, heavy, fast passenger service.

Q. Why is the high speed reducing valve called a compensating valve?

A. Because while operating in service applications as an ordinary safety, or pressure, reducing valve, in emergency applications they hold the maximum cylinder pressure for a limited period of time before commencing to relieve the brake cylinder. This period of time of holding the maximum cylinder pressure is automatically lengthened or shortened according to the variations had in the maximum brake cylinder pressure, or in the piston travel, or in both combined. As the valve makes allowance or "compensates" in time of hold of maximum brake cylinder pressure on account of these variations, the closure of all the valves upon a train will be practically uniform.

Q. Of what does the compensating valve consist essentially?

A. Of a piston valve working in a bushing or cylinder; two packing rings that act as valves for the relief and leakage ports; a regulating spring by which the piston is held in its normal position against the brake cylinder pressure; a regulating nut or screw by which the tension of the regulating spring may be adjusted; a body; spring case; a spring box; a cap nut, and a non-return check valve, with casing complete.

Q. What is the duty of the non-return check valve, which is screwed into spring box?

A. In emergency applications the air which is vented from the brake pipe into the spring box must pass the non-return check valve, which then seats and prevents the air thus trapped in the spring box from escaping or backing out, except as it passes out slowly through the small port drilled through this check valve.

Q. How is the compensating valve piped to the brake cylinder and to the triple valve?

A. A ½-inch pipe connection is made from the chamber above the piston in style A to the brake cylinder; and another is made from the side cap of the quick action triple valve to the spring box and air chamber below piston. In style B but one pipe connection is necessary, that from chamber B to the brake cylinder.

Q. Should these pipe connections be absolutely air tight?

A. The pipe connection from the brake cylinder to the chamber above the piston should be absolutely air tight; the pipe connection from the side cap of the triple to the non-return check valve and spring box air chamber should be securely tight.

Q. Describe the operation of the compensating valve, style A.

A. During an emergency application a portion of the brake pipe air vented at the side cap of the quick action triple valve, passes through the pipe leading to the non-return check valve and spring box air chamber, charging the spring box chamber, under the piston, with air pressure. This air pressure augments, or reinforces, the regulating spring pressure under the piston, and permits the full equalized pressure from the auxiliary reservoir to be had in the brake cylinder, and to be retained therein for several seconds before the piston can descend and open the relief ports. The air vented into, and trapped in, the spring box air chamber requires several seconds to pass back to the atmosphere through the small port in the non-return check valve. When the air pressure in the spring box chamber has reduced sufficiently the piston will be forced down by the brake cylinder pressure above it, the relief ports controlled by packing rings will be opened, and brake cylinder pressure will be gradually reduced to the point of adjustment of the valve.

In service applications, there being no air vented into the spring box air chamber, the only pressure which the piston has to overcome is that of the regulating spring; therefore, when the brake cylinder pressure is sufficient to overcome the spring pressure the piston will descend promptly and open the relief ports.

Q. Should all joints around the spring box air chamber be made air tight?

A. Yes; in bolting the spring box to the body of the valve care should be taken to see that the gasket is in good condition and bolted up tight; next the plug that is screwed into the hole that is not used for the non-return

check valve, in the spring box, should have a little lead rubbed upon it and be screwed so as to make an air tight joint. The same rule should be observed when screwing the non-return check valve into the other hole. After adjusting the regulating spring the cap nut should be screwed up tight so that no leakage will be had past it.

Q. Why is it necessary to have the spring box air chamber air tight?

A. So that air trapped in there by the non-return check valve will find no means of escape except through the small port in this check valve.

Q. What is the duty of the leather washer on top of the piston?

A. It forms an air tight joint between the brake cylinder and the atmosphere.

Q. What is the function of the upper packing ring of the piston?

A. It makes an air tight joint all around in the cylinder, preventing brake cylinder pressure from leaking past it into the spring box chamber, and it also seals, or closes, the relief ports when in normal position.

Q. What is the function of the lower ports controlled by the lower packing ring?

A. The lower ports are leakage ports, and their function is to carry away to the atmosphere what air may possibly leak by the upper packing ring, thus preventing any leakage down into the spring box air chamber. Leakage from above the piston into the spring box chamber would form a pressure there which might tend to balance the piston, and retard the escape of air from the brake cylinder.

Q. What is the function of the lower packing ring in the piston?

A. The lower packing ring when the piston is in its normal position, seals the leakage ports, and prevents the spring box air leaking by this ring to the atmosphere in emergency applications.

Q. When the piston has moved to the lower end of its stroke, what is the position of the leakage ports relative to the upper and lower packing ring?

A. When the piston moves down its full stroke these ports are about midway between the upper and the lower packing rings; from this it may be seen that the leakage by the upper packing ring would pass out through these ports.

Q. What is the advantage of holding the maximum cylinder pressure obtainable from a reservoir pressure of 110 pounds in emergency applications?

A. At speeds of 60 miles per hour and higher, usually considered high speed, an emergency application is more effective in retarding the motion of the train if the maximum cylinder pressure is retained until the speed of the train has reduced to 15 or 10 miles per hour.

Q. At what pressure is the compensating valve usually adjusted?

A. About 60 pounds, although for driver brakes, tender brakes, and such cars as have not standard foundation brake gear, the adjustment is sometimes varied from this.

Q. Aside from the advantages had in an emergency application with the use of the compensating valve and the brake pipe pressure of 110 pounds, what other advantages are had?

A. In service two or more powerful applications can be made, without recharging the auxiliary reservoirs, and still have sufficient pressure left to make an ordinary

emergency application, such as would be had from a 70-pound brake pipe pressure.

Q. Suppose a service application were made, reducing the brake pipe pressure 15 pounds, then a release was made, and then suddenly an emergency application was required, what would the result be?

A. The reservoirs would probably contain about 95 pounds pressure; this would equalize in the brake cylinder at about 75 pounds or a little over with 7-inch piston travel, and the spring box chamber would be charged with the vented brake pipe air to about the same pressure as from 110 pounds. The effect, therefore, would be to maintain the lower maximum cylinder pressure of 75 pounds for several seconds longer than the higher maximum of 85 pounds, had in an emergency application from 110 pounds pressure.

Q. Why is this?

A. Because the spring box chamber air pressure would have to reduce to a lower point before the cylinder pressure could force the piston down to open the ports.

Q. Can the compensating valve be used on any size of cylinder?

A. Yes; the compensating valve can be used on any size of cylinder—6, 8, 10, 12, 14 or 16-inch.

Q. Will the rate of reduction in brake cylinder pressure be about the same when the compensating valve is used on the 16-inch cylinder as it is on the 10-inch?

A. Yes.

NEW YORK AIR SIGNAL EQUIPMENT.

Q. What are the essential parts of the train air signal equipment?

A. They consist of a signal pressure reducing valve, a signal valve, a signal whistle, a car discharge valve, a signal hose and coupling, with the necessary signal piping, stop cocks, cut-out cocks and signal pipe strainers.

Q. What is the function of the signal pressure reducing valve?

A. To maintain the required signal pipe pressure regardless of what the main reservoir pressure may be.

Q. What is the recommended amount of pressure for use with the air signal?

A. About 40 pounds; practice having demonstrated that under average conditions the best results are obtained with this amount of pressure.

Q. How does the pressure reducing valve operate?

A. The tension of the regulating spring on the diaphragm holds the supply valve off its seat to allow main reservoir air to flow into the signal pipe. As soon as the pressure in the signal pipe and the chamber under the diaphragm is sufficient to overcome the tension of the regulating spring (usually about 40 pounds) the diaphragm rises, and the supply valve spring, assisted by main reservoir pressure, forces the supply valve to its seat, thus closing the communication between the main reservoir and the signal pipe.

When the signal pipe pressure reduces below 40 pounds, or whatever the adjustment may be of the valve regulating spring, this spring forces the diaphragm down, unseating the supply valve and establishes communication again between the main reservoir and the signal pipe.

Q. What parts are contained in the signal valve?

A. The upper case, the rubber diaphragm, the dia-

phragm stem complete, the lower diaphragm plate, the diaphragm nut, the air valve, four ½-inch tee head bolts, the cap, the upper diaphragm washer and the lower case.

Q. What is the function of the signal valve diaphragm?

A. When a reduction is made in signal pipe pressure, to raise the air valve and cause the whistle to sound a blast.

Q. What is the function of the air valve?

A. To control the flow of air from the signal valve to the signal whistle.

Q. How does the signal valve operate?

A. When the signal pipe pressure is reduced suddenly, as when the car discharge valve is opened, the air flows from the chamber above the signal valve diaphragm faster than it can come back through the equalizing port in the diaphragm stem from the lower air chamber. As a consequence, the diaphragm is then forced upward, and the three prongs, or uprights, of the diaphragm stem force the air valve from its seat. Air then flows to the whistle, causing it to make a blast. As soon as the diaphragm rises, the pressure on both sides of it, above and below, equalize quickly through the passage in the diaphragm stem, and it drops back to its normal position, the air valve is seated, and the flow of air to the whistle is cut off.

Q. How should the car discharge valve be operated to obtain the best results?

A. It should be operated quickly so as to produce a short, quick reduction of the signal pipe pressure.

Q. How much of an opening should be made at the car discharge valve when the cord is pulled?

A. The cord should be pulled hard enough to insure the full opening of the car discharge valve.

Q. How long should the cord be held when giving a signal?

A. About one second.

Q. How long should the car discharge valve remain closed before giving the next blast?

A. About three seconds.

Q. Should more time be given between the blasts on long trains?

A. Yes; better results will be obtained if for every six additional cars placed in a train originally of eight cars, a second is added to the time between the blasts.

Q. Why is the opening in the signal pressure reducing valve at the signal pipe connection made small, or restricted?

A. In order to make the main reservoir air feed gently into the signal pipe.

Q. Where would you look for trouble if, when you release brakes, the signal whistle were to blow?

A. In the signal pressure reducing valve.

Q. What would be the probable trouble?

A. The supply valve would probably be stuck open or be leaking, and as a consequence the signal pipe would have main reservoir pressure in it.

Q. With this condition prevailing, how could releasing the brakes cause the signal to operate?

A. When brakes are released the main reservoir pressure is reduced and the signal pipe pressure being equal to main reservoir pressure before the release, signal pipe air will flow back through the signal pressure reducing valve into the main reservoir. The reduction of pressure

in the signal pipe thus made will cause the whistle to blow.

Q. If no air can be had in the signal pipe, where would you look for the trouble?

A. The reducing valve is probably cut out or stopped up, so that no air can pass through it.

Q. If the signal whistle gives the proper blasts from a short train, but it is impossible to get more than one blast from the rear of a long train, where would you look for the trouble?

A. Examine the signal valve diaphragm; it is probably stretched or distorted.

Q. Why will a distorted diaphragm in the signal valve cause this action?

A. When the pressures are all perfectly equalized, as when the cord is pulled for the first time, the signal valve will probably work with a poor diaphragm, but as the air wave from the second reduction will not flow so perfect to the signal valve, the diaphragm that is in poor shape will operate weakly without moving the diaphragm stem and the air valve.

Q. If the whistle keeps blowing constantly, where would you look for the trouble?

A. Dirt on the seat of the air valve, allowing air to flow constantly to the whistle. If a piece of dirt gets between the diaphragm stem and the center post in the signal valve lower chamber, that is large enough, it will raise the diaphragm up so that the whistle valve will be held off its seat.

Q. If the signal pipe is charged up to the proper pressure, and the whistle does not blow when the cord is pulled from the first car, where would you look for the trouble?

A. The whistle or the pipe leading from the signal valve

to the whistle may be stopped up. A bad leak in this pipe would prevent the whistle blowing.

Q. How would you ascertain if the trouble was in the whistle?

A. Remove the whistle from the pipe to see if any air comes through the pipe when the cord is pulled.

Q. If on pulling the signal cord on one car it is found that air does not escape at the car discharge valves ahead and back of this one, where will the trouble be?

A. If the cut-out cock is open to the discharge valve it is likely the leather seat is loose in the discharge valve stem, or what is more likely, the pipe strainer is blocked up with dirt.

Q. How will this prevent the escape?

A. If the leather seat is loose the pressure will get in behind the seat and the stem will be operated without forcing it off its seat. If the strainer is blocked with dirt no air can get through it.

Q. If the car discharge valve leaks, what should be done?

A. The cut-out cock in the branch pipe should be closed, if it leaks badly, and the valve removed for inspection and repairs.

Q. Where and in what position should the signal pressure reducing valve be located?

A. In the cab, in an upright position, to prevent freezing.

QUESTIONS AND ANSWERS

NEW YORK AUTOMATIC CONTROL EQUIPMENT

Q. What advantages are claimed for the automatic control equipment?

A. It posses all the advantages of the combined automatic and straight air system, besides being adapted for use on all locomotives, whether high speed or ordinary passenger service, freight or switching service.

Q. Mention three prominent characteristics of this equipment.

A. With it the locomotive or train brakes can be used together or separately as desired. The brakes can be applied as lightly, or as heavily as desired.

The locomotive brakes may be graduated on and off as desired.

Q. What is one very important feature of the automatic control equipment?

A. The automatic and straight air brakes are maintained as two separate units. If either should become inoperative it will not interfere with the proper operation of the other.

Q. Name the different parts of the automatic control equipment.

A. 1, Automatic control valve; 2, automatic brake valve; 3, independent brake valve; 4, double throw check valve; 5, double pressure feed valve; 6, reducing valve; 7, 8, two duplex air gauges; 9, special release valve.

Q. What rules should be observed in the operation of this equipment?

A. Practically the same as those given for the combined automatic and straight air equipment.

Q. When the independent brake alone is used where should the handle of the automatic brake valve be carried?

A. In running position.

Q. What method should be pursued when descending heavy grades?

A. Use the locomotive and train brakes alternately.

AUTOMATIC CONTROL VALVE.

Q. What are the main functions of the automatic control valve?

A. The automatic control valve with double chamber reservoir takes the place of triple valves, auxiliary reservoirs, high-speed reducing valves, etc., heretofore required in the automatic brake system for locomotive and tender.

Q. What is the function of the quick action cylinder cap?

A. It enables the automatic control valve to vent brake pipe air into brake cylinder in emergency applications, in the same manner as does the quick action triple valve.

Q. After an application, how may the engine brakes be released independently of the train brakes?

A. By allowing air to discharge from the control reservoir through the release valve located in the cab.

Q. Should it be desired to again apply the engine brakes without making a further reduction of brake pipe pressure, how may it be done?

A. By means of the straight air brake valve.

Q. If a partial release of the automatic brakes on the engine is made with the release valve, and straight air

is then applied, how can the engine brakes be released without releasing train brakes?

A. By using the release valve in addition to placing the straight air brake valve in release position.

TYPE L AUTOMATIC BRAKE VALVE.

Q. What brake valve is used with the automatic control equipment?

A. The type L automatic brake valve.

A. How many and what are the positions of the type L brake valve handle?

A. Six; as follows: release, running, holding, lap, service and emergency.

Q. What occurs when the handle is in release position?

A. A large direct passage is provided for the air from main reservoir to brake pipe, for quick release and recharge of the brakes; and, if locomotive brakes are applied, to prevent their release.

Q. What would occur if handle was kept in release and charging position?

A. The entire brake system would be charged with air at main reservoir pressure.

Q. How is this prevented?

A. By moving the handle to running or holding position when the desired effect has been obtained.

Q. How is the engineer warned that the handle is in release and charging position?

A. By the escape of air to the atmosphere through a small warning port.

Q. In what position should the handle be when the brakes are not being operated, and to release the locomotive brakes?

A. Running position.

Q. What occurs during the time that the brake valve is in running position?

A. A direct air passage of large size leads from the feed valve pipe to brake pipe, and brake pipe pressure will increase to the pressure at which the feed valve is adjusted. Chamber D and the equalizing reservoir are charged with air at the same rate as the brake pipe. Air from main reservoir also passes to the pump governor through ports in the rotary valve and seat, and thence to the lower connection of the excess pressure head of the governor.

Q. If uncharged cars are cut in while the handle of the automatic brake valve is in running position, or if the handle is moved back into running position too quickly after releasing brakes, what will happen?

A. The pump will be stopped by the governor until there is less than 20 pounds difference showing between the hands on gauge No. 1.

Q. What pressures are indicated by gauge No. 1?

A. One hand shows main reservoir pressure, the other shows the pressure in the equalizing reservoir.

Q. What pressures are indicated by gauge No. 2?

A. One hand shows brake pipe pressure, and the other shows locomotive brake cylinder pressure.

Q. What rule should be observed when releasing brakes after a heavy application?

A. Do not move the handle into running position before all brakes have been released and the system nearly recharged.

Q. What results when the handle is placed in service position?

A. A gradual reduction of brake pipe pressure, air be-

ing discharged to the atmosphere at the proper rate from chamber D, and equalizing reservoirs.

Q. What are the functions of lap position?

A. It holds the brakes applied until it is time to release, or re-apply them. It is also used to prevent loss of main reservoir pressure in case the train breaks in two, or burst hose, or the use of conductor's valve.

Q. What is release position for?

A. For releasing train brakes only, the engine brakes remaining applied.

Q. When the desired effect has been obtained with the handle in release, where should it then be placed?

A. In holding position if the engine brakes are to be kept on; or running position to release them.

Q. What is the purpose of holding position?

A. To keep the locomotive brakes on after train brakes have been released.

Q. What occurs when the handle is moved to emergency position?

A. Brake pipe pressure is suddenly discharged to the atmosphere through a large passage by way of the rotary valve and seat thus causing emergency action of the triple valves, and instantaneous application of the brakes at full power.

Q. Is air pressure maintained in the control reservoir of the automatic control valve during an emergency application?

A. Yes.

Q. What becomes of the air in the equalizing reservoir during emergency?

A. It is all discharged through the rotary valve and passes to the atmosphere.

INDEPENDENT BRAKE VALVE.

Q. Of what type is the independent brake valve?

A. It is a slide valve operated by a lever.

Q. How many, and what are the positions of this valve?

A. Four; release, lap, service and emergency.

Q. In what position should the handle of the independent brake valve be carried when this brake is not in use?

A. Release position, always.

Q. What is the purpose of lap position with this valve?

A. To keep the engine brakes on after they have been applied at the desired pressure.

Q. What occurs when the independent brake valve is placed in service position?

A. A small port in the slide valve seat is uncovered through which air can pass from the chamber above the slide valve to the locomotive brake cylinders, applying the brakes gradually.

Q. What is the result when the handle of the independent brake valve is placed in emergency position?

A. The slide valve fully uncovers the large port leading to the brake cylinder pipe, allowing the air to pass rapidly from the reducing valve pipe to the engine brake cylinders.

Q. What is usually the maximum pressure obtained in the engine brake cylinders?

A. Forty-five pounds. This supply is controlled by the adjustment of the reducing valve.

DOUBLE PRESSURE FEED VALVE.

Q. What is the purpose of the double pressure feed valve?

A. To provide high and low brake pipe pressure control.

Q. What pressures are regulated by this valve?

A. Brake pipe pressure, and feed valve pipe pressure, when the handle of the automatic brake valve is in either running or holding position.

Q. What is the advantage of having the duplex adjusting arrangement of this feed valve?

A. It avoids the necessity of using two feed valves in high and low pressure service.

Q. How is the regulation of the valve accomplished?

A. By turning the handle until its pin strikes either one of the stops, thus increasing or decreasing the compression of the regulating spring.

SINGLE PRESSURE FEED VALVE.

Q. What is the purpose of the single pressure feed valve?

A. It is used to control the pressure for operating the independent brake; also the signal system when desired; in which case it is called a reducing valve.

Q. In what way does it differ from the double pressure feed valve?

A. In the adjustment feature which is used for reducing main reservoir pressure to the 45 pounds required for the independent brake.

Q. How is this valve adjusted?

A. Remove the cap nut, and adjust the tension of the spring by means of the adjusting screw.

DUPLEX PUMP GOVERNOR.

Q. Describe the function of the duplex pump governor used with the automatic control.

A. It changes the main reservoir pressure automatically when the brake pipe pressure is changed from low to high by the feed valve; and controls the speed of the pump accordingly.

Q. In what positions of the automatic brake valve is this governor in action?

A. Release, running and holding positions.

Q. Is it cut out in all the other positions of the automatic brake valve?

A. It is.

Q. With what is the maximum pressure head of the duplex governor always in direct communication?

A. The main reservoir.

Q. Why? Explain.

A. So that this head will control the pump when the other or excess pressure head is cut out by the brake valve; or the main reservoir cut-out cock is closed.

Q. How is the maximum pressure head adjusted?

A. Place the handle of the automatic brake valve in lap position, remove cap nut of governor and change tension of the spring with regulating nut until it is adjusted so as to stop the pump when the desired maximum main reservoir pressure is obtained.

Q. For what pressure should this head be adjusted?

A. A pressure of from 120 to 140 pounds, according to the service.

Q. How is the excess pressure head of this governor adjusted?

A. Place the handle of automatic brake valve in run-

ning position, remove cap nut, and change tension of the spring by means of the regulating nut, until the desired difference between main reservoir and brake pipe pressure is obtained.

Q. How much excess pressure should this head be adjusted for?

A. Twenty pounds excess pressure in main reservoir.

COMBINED AIR STRAINER AND CHECK VALVE.

Q. Describe the location and purpose of the combined air strainer and check valve.

A. Two of these are used with the automatic control equipment; one being in the continuous feed pipe to prevent back leakage from the auxiliary reservoir of the automatic control valve, and the other being part of the dead engine fixture.

Q. Of what does the dead engine fixture consist?

A. A pipe leading from brake pipe to main reservoir, a cut-out cock and the combined check valve and strainer.

Q. When two or more locomotives are operating together on one train and the air pump on one engine becomes inoperative, how may the air for operating the brakes on such locomotive be supplied to it?

A. With the cut-out cock open, air from the brake pipe enters and passes through the strainer, lifts the check valve and flows on into the main reservoir thus supplying this engine with the air pressure necessary to operate its brakes.

Q. What precautions should be observed when operating engine brakes in this way?

A. The cut-out cock in the brake pipe under the automatic brake valve should be closed, and the handle of the brake valve placed in running position.

Q. If it becomes necessary to keep the maximum braking power of a dead engine below standard how may it be done?

A. By changing the adjustment of the safety valve of the automatic control valve. The pressure can also be reduced by using the release valve.

Q. How is the seating of the check valve assured?

A. By means of the spring.

QUESTIONS AND ANSWERS.

NEW YORK B-2 H. S. EQUIPMENT.

Q. What are the principal features of the B 2 H. S. equipment?

A. The engine brakes can be operated at all times, either by automatic or independent application, regardless of the location of the engine in a train. They can be graduated off after an application, thus avoiding all shock. All excess pressure is confined to the main reservoir, thus preventing overcharging of the auxiliary reservoirs.

Q. How many, and what are the schedules into which this equipment is divided?

A. Three; as follows: Schedule B 2, single pressure system; Schedule B 2-H. P., double pressure system, and B 2-H. S. double pressure with high speed attachment.

Q. What service is the B 2 equipment designed for?

A. For passenger or freight service where but one brake pipe pressure is used.

Q. For what service is the B 2-S equipment?

A. Switch engines.

Q. What service is the B 2-H. P. equipment used in?

A. Freight service, only.

Q. What is the B 2-H. S. equipment?

A. It is a high speed locomotive equipment.

Q. What system of regulation is used with the B 2, and B 2-S equipments?

A. Single pump governor and single pressure controller.

Q. What system of regulation is employed with the B 2-H. P. and B 2-H. S. equipments?

A. A duplex pump governor, and duplex pressure controller.

Q. In what respect does the B 2 brake valve differ from the B and B 1 brake valves?

A. It is constructed so as to embody the features of the pressure controller, and those of united straight air.

Q. How many, and what are the different positions of this brake valve?

A. Six; as follows: release, running, lap, first graduating, last graduating and emergency.

Q. What are the two graduating positions for?

A. To give a gradual reduction of brake pipe pressure for service applications.

NEW YORK B-3 EQUIPMENT.

Q. What is the B 3 locomotive brake equipment?

A. It is the New York Air Brake Company's locomotive air brake equipment which has the automatic and straight air operating features combined in one brake valve.

Q. In how many schedules is this equipment furnished?

A. Four.

Q. Why these different schedules?

A. To suit the requirements of the different classes of railroad service. Switch engines, for instance, do not require all the parts necessary for road engines.

Q. What are its principal constructive features?

A. (a) It does away entirely with the separate straight

engineer's brake valve. (b) Combines in one engineer's valve all the operative features of the standard automatic engineer's brake valve, and of the straight air brake engineer's valve.

Q. What are its principal operative advantages?

A. (a) But one engineer's valve, with only the usual positions of former styles of automatic valves to manipulate in using either the locomotive straight air brake or the automatic locomotive and train brakes.

Q. What are the principal new operative parts used with the B 3 equipment?

A. (a) B 3 engineer's brake valve; (b) Pressure controller; (c) Accelerator valve; (d) Divided reservoir; (e) High speed controller; (f) Lever safety valve; (g) Quick release valve; (h) Supplementary reservoir.

Q. What are the principal parts of the B 3 brake valve?

A. (a) The main slide valve; (b) Piston; (c) Graduating valve; (d) Vent valve; (e) Supplementary reservoir.

Q. Into how many chambers is the valve divided?

A. Three.

Q. What are these chambers called?

A. Main reservoir, or chamber "B," brake pipe, or chamber "A" and supplementary reservoir, or chamber "D."

Q. What separates chamber "B" from chambers "A" and "D?"

A. The main slide valve.

Q. Is full main reservoir pressure carried in chamber "B?"

A. Not when the main reservoir pressure is above the standard brake pipe pressure.

Q. What is the greatest pressure admitted to chamber "B?"

A. The maximum brake pipe pressure.

Q. Why then is chamber "B" called a main reservoir chamber?

A. Because, while the air in chamber "B" does not exceed maximum brake pipe pressure, it is not brake pipe air, as the slide valve is the actual dividing line between the main reservoir and brake pipe, and controls the flow of air from the main reservoir to the brake pipe for the purpose of releasing the brakes and charging the brake pipe and auxiliary reservoirs, it is obvious that chamber "B" must be considered as part of the main reservoir.

Q. Where then does main reservoir pressure begin, and where does it end?

A. It begins at the air pump and ends at the slide valve in chamber "B."

Q. Of what is chamber "A" really a part?

A. It is a part of the brake pipe.

Q. What pressure is carried in chamber "A" at all times?

A. Brake pipe pressure.

Q. Of what use is chamber "D?"

A. It contains the pressure that operates the automatic cut-off of the brake pipe exhaust in service reductions.

Q. What pressure is the air in chamber "D" equal to?

A. It is equal to brake pipe pressure.

Q. What are the duties of the main slide valve?

A. Generally speaking, to admit air to and discharge it from the various parts of the equipment to which air is to be admitted, and from which it has to be discharged. They can best be described by taking each position separately.

B 3 BRAKE VALVE.

Q. How many positions has the B 3 engineer's brake valve?

A. Five positions.

Q. Name them.

A. Automatic release and straight air application position, running and straight air release position, lap position, service application position and emergency application position.

Q. Why is the usual release position called the automatic release and straight air application position with this type of valve?

A. Because, while it is a position in which the automatic brakes on the train can be released, it is also a position in which the locomotive straight air brake can be applied.

Q. When is it used?

A. It is used at a time when it is desired to release the automatic brakes on the train, and to hold the locomotive brake applied, as in holding the slack bunched on grades at the time when releasing the train brakes to recharge the brake pipe and auxiliary reservoirs.

Q. How is the service position of this brake valve arranged?

A. Like all types of New York brake valves, it is divided into five graduating positions designated by notches on the quadrant.

Q. What is the quadrant?

A. The part over which the brake valve handle travels, and on which the various stops, denoting the different positions into which the brake valve is to be placed, are arranged.

Q. What is the effect of placing the valve handle in any one of the service graduating positions?

A. A certain reduction of brake pipe pressure is made.

Q. Is this reduction the same in any notch that the valve handle is placed in?

A. No; it varies with each notch.

Q. What reduction is obtained in the first notch?

A. About five pounds.

Q. If the valve handle is moved directly to the second notch without stopping at the first, what reduction is obtained?

A. About eight pounds.

Q. If the handle is moved directly to the third notch without stopping at either of the first two, what reduction is obtained?

A. About eleven pounds.

Q. If the handle is moved directly to the fourth notch without stopping at either of the first three, what reduction is obtained?

A. About fifteen pounds.

Q. If the handle is moved directly to the fifth notch, what reduction would be made?

A. About twenty-three pounds.

Q. If, after the valve handle had been placed in the first notch and a five pounds reduction made, it was moved to the second notch, how much more would the brake pipe reduce?

A. About three pounds, or enough to make the total brake pipe reduction eight pounds, as supposed to be drawn off in this notch.

Q. If the handle is then moved to the third notch, how much more would the brake pipe be reduced?

A. About three pounds again, or enough to make the

total reduction eleven pounds, as supposed to be drawn off in this position.

Q. If the handle is then moved to the fourth notch, how much more would the brake pipe be reduced?

A. About four pounds, or in all fifteen pounds.

Q. If the handle is then moved to the fifth notch, how much more would the brake pipe be reduced?

A. About eight pounds, or enough to make the total brake pipe reduction twenty-three pounds.

Q. Has the fifth graduating notch any other effect than that of making a full service reduction?

A. Yes, it also opens a port which permits the main reservoir pressure to flow into the straight air pipe up to the pressure the straight air controller is set at.

Q. What advantage is gained by this?

A. It keeps the locomotive brakes applied with practically full braking pressure, regardless of long piston travel or brake cylinder leakage.

Q. Where is the graduating valve located?

A. In a cavity in the slide valve seat directly below the slide valve.

Q. On what does the graduating valve seat itself?

A. On the bearing face of the slide valve.

Q. What holds the graduating valve in position?

A. The graduating valve lever, and graduating valve spring.

Q. What gives the graduating valve its motion?

A. The piston.

Q. Is the graduating valve fastened directly to the piston?

A. It is connected to it by means of the graduating valve lever,—the long end of which is connected to the piston, and the short end to the graduating valve.

Q. On what is the graduating valve lever fulcrumed?

A. On the fulcrum pin.

Q. Where is the fulcrum pin located?

A. It is screwed into the body of the brake valve from the handle side and passes through the graduating valve lever as the lever projects up through a passage cored between the cylinder of the brake valve and the slide valve seat.

Q. Where is the graduating valve spring located?

A. In the jaw of the graduating valve lever and inside of the graduating valve.

Q. Where is the piston located?

A. In the cylinder of the brake valve.

Q. What are the duties of the piston?

A. It separates chamber "A" from chamber "D," gives motion to the graduating valve by means of the graduating valve lever, and prevents flow of chamber "D" air to the atmosphere, by means of the vent valve, when the piston is in or returns to its normal position with the brake valve handle in release, running or lap position.

Q. What pressures act on the piston?

A. Brake pipe on the side to which the graduating valve lever is connected and chamber "D" pressure on the vent valve side.

Q. How do these pressures stand when fully charged?

A. Equal.

Q. Does the space between the piston and back cap constitute the volume of chamber "D?"

A. No; the supplementary reservoir is connected to and is part of chamber "D."

Q. Where is the supplementary reservoir?

A. It is generally fastened to the roof of the cab, and

is connected by a pipe to passage "H," which is connected to chamber "D."

Q. Is this reservoir to be considered a part of the engineer's valve?

A. Yes; it is just as much a part of the engineer's valve as the slide valve or piston.

Q. Where does the air come from that supplies chamber "D" and the supplementary reservoir?

A. From chamber "A."

Q. Where does it come from with the B 2 brake valves?

A. From chamber "B."

Q. Why this change?

A. This is simply a structural change, the results obtained being the same with either method.

Q. Is it necessary for the supplementary reservoir to be of a certain size?

A. It is.

Q. What would be the effect if a supplementary reservoir larger than that furnished with the equipment be used?

A. The brake pipe reduction in any particular notch would be less than that intended.

Q. What if a smaller reservoir be used than that furnished?

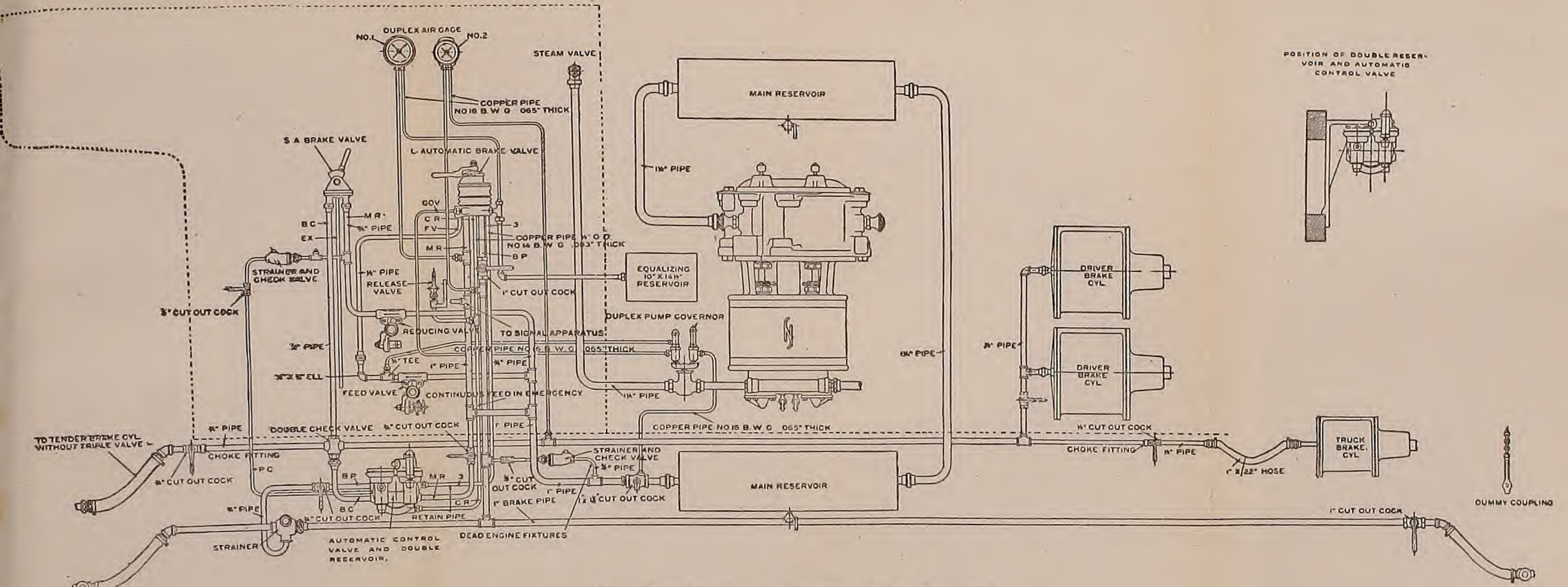
A. Then the reduction would be greater than that intended.

Q. What is the volume of the supplementary reservoir?

A. About 92 cubic inches.

Q. When the brake valve handle is placed in a service notch is air drawn from the supplementary reservoir?

A. No; only from the brake pipe.



Piping Diagram. Style A. (Automatic Control Equipment).

Q. What reduces the pressure in chamber "D" and supplementary reservoir?

A. The movement of the piston to close off brake pipe exhaust increases the space in chamber "D."

Q. What prevents leakage of chamber "D" pressure past the piston into chamber "A?"

A. The piston packing ring, and in addition a packing leather, and expander.

Q. What takes place when the valve handle is placed in a service notch?

A. One of the service application ports is moved away from the graduating valve, and the other is over the exhaust port in slide valve. Brake pipe air is now free to exhaust to the atmosphere, and the pressure in chamber "A" becomes less than that in chamber "D," and the latter pressure now pushes the piston forward causing the graduating valve lever to revolve on the fulcrum and carry the graduating valve toward the open exhaust port in the slide valve to a position where it again covers this port and cuts off further reduction of brake pipe pressure.

Q. If the brake valve handle is moved back to the next notch, what then takes place?

A. The slide valve is moved, carrying the exhaust port away from the graduating valve, and brake pipe air is again free to exhaust to the atmosphere until the expansion of air in chamber "D" once more moves the piston, and it in turn carries the graduating valve to the point where it once more covers the slide valve exhaust port and again cuts off the flow of brake pipe air. This operation is repeated in each of the graduating notches that the brake valve handle may be placed in.

Q. Does the graduating valve close the exhaust in the emergency position also?

A. No; the brake pipe exhaust cannot be closed in the emergency position.

Q. Why not?

A. Because the brake pipe air exhausts through different ports than those controlled by the graduating valve, and because it is not desirable that it should be shut off in emergency.

Q. What becomes of the air in the supplementary reservoir and chamber "D' in an emergency application?

A. It escapes to the atmosphere through port "W," and the emergency exhaust ports in the slide valve.

Q. Do the piston and graduating valve move in an emergency application?

A Yes, as the reduction of chamber "A" pressure is more rapid than that of chamber "D"—but its movement has no effect on the operation of the brake valve.

Q. What brings the piston back to its normal position, when brakes are being released?

A. In the release, running and lap positions, an opening is made from the back of the piston—chamber "D" to the atmosphere, which permits enough air to escape from this chamber to reduce it below chamber "A" pressure, which being the stronger, pushes the piston back to its normal position.

Q. What causes the short exhaust of air from the brake valve each time the valve handle is returned to release, running and lap positions?

A. It is the escape of air from chamber "D."

Q. What cuts off this flow of air?

A. The vent valve.

Q. Where is this vent valve?

A. It is attached to the end of the piston stem on chamber "D" side.

Q. Is this part in one piece?

A. No; there are four pieces, the vent valve, the follower cap-nut, vent valve spring and piston cotter.

Q. What is the follower cap-nut for?

A. It slips over the vent valve and is screwed into the end of a stem projecting from the piston on chamber "D" side,—thus holding the vent valve in place on the end of the piston stem. The part of the vent valve which does the seating to close off the flow of air from chamber "D" projects out of the end of the follower cap-nut through an opening in the cap-nut made for the purpose.

Q. What is the vent valve spring for?

A. To permit the vent valve adjusting itself to its seat. It has to be left a little loose in the follower cap-nut, and the spring is to hold it steadily against its seat, when located.

Q. What is the piston cotter for?

A. It passes through the follower cap-nut and piston stem, thus preventing the follower cap-nut from getting loose and working off the piston stem.

Q. Where is the port that connects chamber "D" with the atmosphere in release, running and lap positions, located?

A. It starts at the center of the back cap, passes through the cap and is cored through the body of the brake valve and then up to the slide valve seat.

Q. Where is the vent valve seat?

A. In the center of the back cap, at the point where this port commences.

PIPE CONNECTIONS.

Q. What is the purpose of the small pipe bracket bolted to one side of the brake valve body?

A. It is for straight air pipe connections.

Q. How many, and what are the pipe connections of the B 3 brake valve?

A. Six; as follows: main reservoir, brake pipe, supplementary reservoir, straight air supply pipe, straight air pipe, and accelerator pipe.

Q. Where does main reservoir pipe connect?

A. To the bottom, on the same side as valve handle.

Q. Where is the brake pipe connected?

A. Underneath, on side opposite to valve handle.

Q. Where is the supplementary reservoir pipe connected?

A. At the front end of brake valve on opposite side from handle.

Q. How does it connect with chamber "D?"

A. By a port passing through the brake valve body.

Q. Where does the accelerator reservoir connect with brake valve?

A. At the front end on same side as the brake valve handle. There is also a hole drilled and tapped on the handle side near the front end, which may be used if more convenient.

Q. Where does the straight air supply pipe connect to the brake valve?

A. To the rear opening in the pipe bracket at side of valve body.

Q. Where does the straight air pipe connect?

A. At the front opening of the pipe bracket.

CUT-OUT COCKS.

Q. What provision is made for cutting off main reservoir pressure in case it is necessary to work on the pressure controller or brake valve?

A. A cut-out cock is placed in the main reservoir pipe between the pressure controller and the main reservoir.

Q. What provision is made for cutting out the brake valve on the second engine, when running double header?

A. A cut-out cock is placed in the brake pipe below the brake valve for this purpose.

Q. What is the use of the cut-out cock in the straight air pipe?

A. To cut out the straight air pipe on engine and tender.

Q. Can the straight air brake on the tender be cut out without interfering with the driver brake?

A. Yes; by means of a cut-out cock on the straight air pipe under the cab near rear of engine.

Q. What provision is made for cutting out the automatic brake?

A. Cut-out cocks are provided for this purpose.

Q. Where is the cut-out cock for cutting out the automatic driver brake placed?

A. Between the driver brake triple valve and double check valve.

Q. Why is it not placed between the brake pipe and triple valve?

A. Because that cuts out the triple valve and prevents the charging of the auxiliary reservoir. With the cut-out cock placed between the triple valve and double check valve, the auxiliary reservoir always remains charged and when cut in, is available for instant use. Cock can be placed between brake pipe and triple valve, however, if so desired.

Q. What kind of cocks are used in the straight air pipe, between the brake valve and double check valve, and between the triple valve and double check valve?

A. These two cut-out cocks are of a special style. They have a hole drilled in one side so that when in the cut-out position, they connect the pipe leading to the double check to the atmosphere.

Q. What is gained by this style of cock?

A. When cut out, no pressure can accumulate in the pipe leading to the double check valve, which insures the double check remaining seated.

PRESSURE CONTROLLER.

Q. How is brake pipe pressure regulated with the B 3 equipment?

A. By means of the pressure controller.

Q. What may the pressure controller be said to be?

A. A device for regulating or controlling brake pipe pressure.

Q. What does it take the place of?

A. The feed valve or excess pressure valve that is usually found on other styles of engineers' valves.

Q. Is this valve a part of the engineer's brake valve?

A. Yes, just as much as the feed valve or excess pressure valve is a part of any ordinary engineer's valve.

Q. Where is it located?

A. In the pipe leading from the main reservoir to the engineer's brake valve.

Q. At what point in this pipe is it generally placed?

A. It is generally placed in the cab near the engineer's valve and handy to the engineer.

Q. To what may its principle of operation be compared?

A. To that of the ordinary pump governor.

Q. Of how many portions does it consist?

A. It is generally considered as having two portions—

the supply portion and the regulating portion, which are usually connected with a pipe, but if more convenient, where the single controller is used, the bracket may be dispensed with and the regulating portion screwed into the cap of the supply portion.

Q. Where is the excess pressure confined with this valve?

A. It is confined to the main reservoir.

Q. How is it confined to the main reservoir?

A. By placing the pressure controller in the pipe between the main reservoir and engineer's valve, and having it so arranged that it shuts off the flow of air from the main reservoir to the brake pipe when the brake pipe is charged to the maximum brake pipe pressure carried.

Q. What are the advantages of this method of controlling brake pipe pressure?

A. (a) No special position of the brake valve is required to get excess pressure. (b) Excess pressure can be obtained in any position of the brake valve. (c) Brake pipe and auxiliary reservoir pressure cannot be raised above the maximum in any position of the brake valve, and therefore the tendency to overcharge the brake pipe and auxiliary reservoirs in releasing brakes, a common result of leaving the brake valve handle in full release position too long with older forms of brake valves, is overcome.

Q. How many sizes of pressure controllers are there?

A. Two; the three-quarter-inch for straight air, and the one and one-quarter for brake pipe pressure regulation.

Q. How many types of these controllers are there?

A. Two; the single, and the duplex.

Q. What is a single controller, and where is it used?

A. It has but one regulating top, and is used on straight air, and on engines where under ordinary conditions the same pressure is carried in both the main reservoir and brake pipe.

Q. What is a duplex controller, and where is it used?

A. The duplex controller has two regulating tops, and is used on engines where the standard brake pipe and main reservoir pressure may be required, or where a higher pressure may be required.

Q. What advantage is gained by the use of the duplex contoller?

A. Either high or low pressure may be cut in or out at a moment's notice, without the necessity of changing adjustment of brake pipe or main reservoir tops.

Q. From whence does the controller take its air pressure?

A. Directly from the pipe between the supply portion and the brake valve.

Q. How is the pressure varied when using the duplex regulating portion?

A. By means of appropriate cocks, according to schedule used, placed in the pipe leading from the air supply to the pressure heads.

Q. How is the regulating portion arranged for attachment in position?

A. It is provided with a bracket so it can be bolted fast to the side of the cab.

Q. How is the adjustment of the regulating portion accomplished?

A. The adjustment of the regulating tops or heads is accomplished by means of adjusting the screw which regulates the tension of the spring the same as in any ordinary governor.

Q. Where is the supply portion of the controller located?

A. This is the part that is placed in the main reservoir pipe between the reservoir and brake valve.

Q. In what way does the supply portion differ from the steam portion of an ordinary governor?

A. It has a leather seated supply valve instead of a metal valve, and has a screw entered into the bottom of the body which runs up to the valve seat and is moved by a hand wheel on the outer end of the screw.

Q. What is the use of this screw?

A. By screwing the wheel up, it will lift the valve off its seat, and allow the free passage of air from the main reservoir to the brake valve.

Q. When would it be necessary to use the hand wheel?

A. It can be made use of in the B 3-S equipment, when the engine is called on to handle a train equipped with the high speed brake, and with any of the schedules in case of any defect that would cause a sluggish action of the pressure controller.

Q. What shuts off the flow of air from the main reservoir to the brake valve?

A. In operation, with either a single or duplex regulating portion, as soon as the pressure in the brake pipe, or chamber "B," is great enough to overcome the resistance of the spring which is holding the diaphragm seated over port "B," the air will pass through the port, through passage below this port, and the pipe that connects the regulating and supply portions to the space above the piston in the supply portion, forcing the piston down, which in turn forces the valve to its seat, thus cutting off communication between main reservoir and brake pipe, or chamber "B."

Q. What and where is this small port "C?"

A. It is a small pin hole drilled through a screw called a muffler plug screwed into a vent opening in the neck of the diaphragm, being the same as the vent opening in the diaphragm of any governor.

Q. What attention must be given to port "C" when using the duplex controller?

A. Each regulating head has a vent port "C;" therefore one of these should be plugged.

Q. What is port "X" in the supply portion of the controller for?

A. It is an exhaust port connecting the under side of the supply portion piston with the atmosphere so that any leakage past this piston may be discharged to the atmosphere.

Q. What care should be taken in locating the supply portion?

A. It should, as much as possible, be away from the boiler head to prevent the drying out of the leather seat.

Q. What is the object of the arrow cast on the outside of the supply portion?

A. This is used as a guide to assist in properly coupling up the supply portion in the piping. The air should pass through in the direction indicated by the arrow.

Q. What is the object of the letters L. & H., cast on the bracket that holds the regulating heads?

A. These letters signify low and high, and the pressure on the side marked "L" should be set for the low pressure, and the one on the side marked "H," for the high pressure.

DIVIDED RESERVOIR.

Q. What is the divided reservoir?

A. A cast iron reservoir, divided by a partition into two separate chambers,—hence the name.

Q. Is this divided reservoir used with all styles of New York brake valves?

A. No, it is only used when the accelerator valve is part of the equipment.

Q. What is the object of the divided reservoir?

A. As previously explained, it is necessary to have a small reservoir to furnish volume to chamber "D," of the engineer's brake valve, and as will be shown, it is also necessary for the accelerator valve to have a small reservoir. The divided reservoir represents these two small reservoirs combined and cast in one piece.

Q. Is there any communication between the two chambers of the divided reservoirs?

A. Absolutely none.

Q. Are the two chambers of equal size?

A. No, one is quite small, as compared with the other.

Q. What is the small chamber used for?

A. It acts as a supplementary reservoir for the engineer's brake valve.

Q. What is the larger chamber for?

A. It acts as the accelerator valve reservoir.

Q. What are the capacities of these two chambers?

A. The supplementary reservoir chamber contains 92 cubic inches, and the accelerator reservoir chamber 600 cubic inches.

Q. How may the large chamber be distinguished from the small one?

A. When coupled up the accelerator valve is attached

to the large chamber. When not coupled, by means of the two studs projecting from the large chamber end to fasten the accelerator valve with.

Q. To what is the small chamber connected?

A. To the supplementary reservoir.

Q. Where is the divided reservoir located?

A. Usually under the running board, directly beneath the cab.

Q. What are the plugs in its bottom for?

A. To drain the chambers, which should be done frequently.

ACCELERATOR VALVE.

Q. What is the function of the accelerator valve?

A. It serves to accelerate discharge of air from the brake pipe in making service reductions on long trains.

Q. When does it operate?

A. Only when service applications are made with the brake valve, and then only when the volume of brake pipe air is sufficient to warrant its use.

Q. Is the amount of air discharged from the brake pipe greater when the accelerator valve is used than would be the case if the brake valve alone was used?

A. No.

Q. What controls the flow of air that actuates the accelerator valve?

A. The flow of air to the accelerator which actuates it is controlled by the automatic cut-off of the engineer's brake valve.

Q. Is the action of the accelerator valve automatic?

A. It is.

Q. How many cars must be in a train to obtain the action of the accelerator valve?

A. About eight cars.

Q. Why will it not operate with less than eight cars?

A. Because, with less than this number of cars, the automatic lap of the brake valve takes place before sufficient pressure has been accumulated in the accelerator reservoir to move the piston of the accelerator valve down against its spring.

Q. How many pounds pressure is required in the accelerator reservoir to operate the accelerator valve?

A. About ten to twelve pounds.

Q. About how long does it take after the brake valve is placed in a service notch to open the accelerator valve on trains long enough to bring it into use?

A. About four seconds.

Q. Does it close as soon as the exhaust from the brake valve ceases?

A. No, it continues to blow for about four seconds, after the brake valve exhaust ceases.

Q. Why is this?

A. Because it takes about that long after the brake valve exhaust closes for the pressure in the accelerator reservoir to reduce sufficiently to allow the valve to resume its normal position.

Q. Why not have it so arranged that it will operate on a less number of cars?

A. Because the brake valve is capable of taking care of short trains.

Q. Does the accelerator consist of more than one chamber?

A. Yes,—it has two chambers, known as B. & O.

Q. Name the working parts of the accelerator valve.

A. The piston, valve stem, slide valve, slide valve spring, valve stem leather seat and spring.

Q. Where is the piston located?

A. In chamber "B."

Q. What pressure acts on the piston?

A. The air in the accelerator reservoir acts on the upper side of the piston.

Q. What is this piston for?

A. To give motion to the slide valve.

Q. Where is this slide valve located?

A. In chamber "O."

Q. What pressure is always present in chamber "O?"

A. Brake pipe pressure is always present in chamber "O," and around the slide valve.

Q. What prevents brake pipe pressure in chamber "O" from passing the chamber "B?"

A. The leather seat on the valve stem, which rests against the seat formed on valve stem bush, and which is held up to this seat by the spring.

Q. What is the slide valve for?

A. The slide valve is to permit the escape of brake pipe air when moved into the proper position, by the piston in chamber "B," acted upon by the pressure accumulated in the accelerator reservoir, during a service reduction in a long train, and to shut off this flow of air when the reduction has been made, and the air in the accelerator reservoir has escaped.

Q. What is the shape of the exhaust port in the slide valve?

A. It is oblong in shape.

Q. What is the shape of the exhaust port in the slide valve seat?

A. It is triangular in shape, with its point upward.

Q. Why triangular in shape?

A. To permit of a slow closure of the accelerator valve exhaust.

Q. Why should the accelerator valve exhaust have a slow closure?

A. For the same reason that the service exhaust of the brake valve should have a gradual cut-off to prevent the release of the head brakes.

Q. Of what use is the slide valve spring?

A. To hold the slide valve to its seat and prevent dirt or other foreign substances getting under it, when chamber "O" is not charged with air.

Q. To what pressure is the accelerator valve connected?

A. Brake pipe pressure.

Q. Explain the operation of the accelerator valve.

A. During a service application a portion of the air from the brake pipe passes to the accelerator reservoir and thence to the top of the piston in the accelerator valve. When 10 or 12 pounds pressure has accumulated in the reservoir and on top of the piston, the latter moves down carrying with it the slide valve and stem, and compresses the spring. The oblong port in slide valve registers with the triangular port in the seat, the port opening being very small at first, but gradually increasing until piston and slide valve have reached full travel. When the cut-off valve of the brake valve goes to automatic lap, further flow of air to accelerator reservoir is stopped, and the pressure on the piston is reduced until the spring pushes it and the slide valve upward stopping the further flow of brake pipe air to the atmosphere.

Q. What is the result of this action of the accelerator valve?

A. A much larger volume of air is discharged from the brake pipe in a given time than could pass through the service exhaust ports of the brake valve.

Q. Does the accelerator valve exhaust stay open longer with a long train than with a short one?

A. Yes,—because with a long train the volume of brake pipe air to be reduced is greater and the cut-off valve of the brake valve remains open longer.

Q. What is the object of the cut-out cock placed in the brake pipe connection leading to the accelerator, as practised on some railroads using this equipment?

A. So that a quick means may be provided for cutting out the accelerator, if the brake pipe connection should break off at the accelerator or the accelerator become defective.

HIGH SPEED CONTROLLER.

Q. What is the high speed controller for?

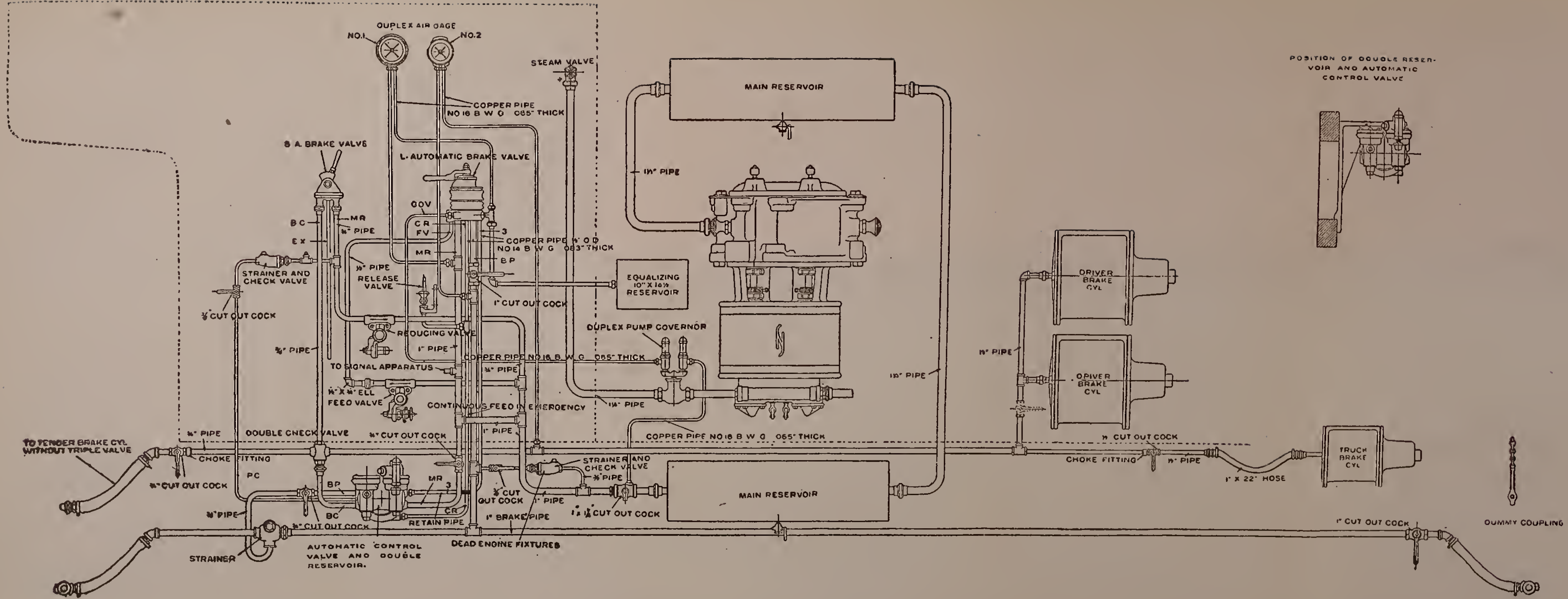
A. It acts as a reducing valve for the driver and truck brake cylinders.

Q. What valves does the high speed controller take the place of?

A. It takes the place of the usual compensating or high speed reducing valve, for driver and truck brake cylinders, and the usual safety valve used to prevent the brake cylinder pressure from becoming too high when the straight air and automatic brakes are both in use, and at the same time provides a means of reducing the pressure in the driver and truck brake cylinders to any extent desired or entirely releasing them without interfering with the train brakes.

Q. Of what does it consist?

A. It consists of a cylinder containing a piston and



Piping Diagram Style B (Automatic Control Equipment).

valve and a lever safety valve screwed into the cylinder.

Q. To what is it connected?

A. On the bottom, to the brake cylinders and on the end, to the brake pipe.

Q. Name the operating parts.

A. In the cylinder are a piston and a piston valve, and in the safety valve, a spring, valve stem, pop valve and lever handle.

Q. Describe the piston and valve.

A. This consists of a piston having a leather seat on each face and is fastened to the piston valve which has two annular grooves, one large and one small.

Q. What pressures act on the piston?

A. Brake pipe pressure on the plain side, and brake cylinder pressure on the piston valve side.

Q. What pressure acts on the piston valve?

A. Brake cylinder pressure.

Q. What is the normal position of the piston and valve?

A. Brake pipe pressure pushes it over in the direction of the solid seat and holds it firmly seated so that no brake pipe air can get into the piston valve chamber.

Q. How does the piston valve stand in this position?

A. With the large annular groove standing over the opening leading to the brake cylinder and under the port leading up to the safety valve.

Q. Does the piston move during ordinary brake applications?

A. No, it does not, unless the brake pipe pressure is reduced below that in the brake cylinders.

QUICK RELEASE VALVE.

Q. What is the quick release valve?

A. A valve used to hasten the release of the engine brakes after either an automatic or straight air application of the brakes, or if desired after a straight air application only, leaving the release of the automatic brakes normal.

Q. With what schedule is this valve furnished?

A. Usually with the B 3-S equipment.

Q. Can this valve be used successfully on switch engines equipped with the older types of brakes?

A. It can.

Q. What are the operating parts of this valve?

A. A piston, rubber seated valve and spring.

Q. Where is this valve usually located?

A. In the brake cylinder pipe between the cylinders and the double check valve when intended to hasten the release of both straight air and automatic brakes.

Q. Where located when used to hasten the release of the straight air brake only?

A. In the straight air pipe between the brake valve and double check valve.

Q. How many pipe connections has this valve?

A. Three.

Q. How is it connected up when used to hasten the release of either the automatic or straight air brake?

A. The end having the ¾-inch union swivel and nut is connected to the brake cylinder side of the piping and the opposite side to the double check valve side of the piping. The bottom connection is to take an exhaust pipe if desired.

Q. How connected when used for hastening the release of the straight air brakes only?

A. The side with the union swivel and nut is connected to the piping leading to the double check valve,—the opposite side, to the straight air pipe leading to the brake valve.

STRAIGHT AIR BRAKE.

Q. What is meant by the term "straight air?"

A. Air that passes direct from main reservoir to brake cylinder without first passing through triple valves or auxiliaries.

Q. What brakes only are operated by straight air?

A. The locomotive and tender brakes.

Q. How is it admitted to and discharged from engine and tender brake cylinders?

A. By means of the combined automatic and straight air brake valve.

Q. Is this air taken from chamber "B" of the brake valve?

A. No; a separate pipe carries it directly from main reservoir to brake valve.

Q. What is this pipe called?

A. The straight air pipe.

Q. Is this pipe connected directly to the main reservoir?

A. No, it is connected to the main reservoir pipe between the main reservoir cut-out cock and the pressure controller.

Q. How is it connected to the brake valve?

A. By means of a pipe bracket bolted to the side of the brake valve.

Q. At what pressure is it admitted to the brake cylinder?

A. Forty pounds.

Q. If this air comes direct from the main reservoir pipe, how is it reduced to 40 pounds?

A. By means of a controller valve used especially for this purpose.

Q. Where is this controller valve located?

A. In the straight air pipe between its main reservoir connection and the brake valve.

Q. What kind of a valve is this?

A. It is a ¾-inch controller valve of the same design as the one used to control the brake pipe pressure, but with a single pressure top.

Q. To what is the pipe leading to the regulating top of this controller connected?

A. To the straight air pipe which leads from the brake valve to the brake cylinders at a point between the brake valve and double check valve.

Q. How is the pressure adjusted?

A. By removing the top cap and screwing the adjusting screw down for more pressure, or up for less,—the same as with a pump governor.

Q. What position must the brake valve be placed in to apply the straight air locomotive brakes?

A. In release and straight air application positions.

Q. Must the full 40 pounds be admitted each time the brake is applied?

A. Not necessarily. It can be admitted to any extent up to 40 pounds.

Q. How is this arranged for?

A. By means of a lap position located about midway between release and running positions.

Q. How would you partially apply this brake?

A. By going to release and then back to the straight air lap position.

Q. Suppose you wanted to apply the brake harder?

A. Would repeat this operation until fully applied or the desired braking force was obtained.

Q. In what position must the brake valve be placed to release the straight air locomotive brake?

A. In running and straight air release position.

Q. Can this brake be graduated off?

A. Yes, if so desired.

Q. How?

A. By moving the handle to running position and letting part of the air escape from the cylinders, then return it to straight air lap. This can be repeated as desired until fully released.

Q. What effect does variation of piston travel have on the straight air brake?

A. None. A constant pressure of 40 pounds is maintained in the cylinders, regardless of piston travel.

Q. What effect does ordinary brake cylinder leakage have on the straight air brake?

A. The straight air will keep the brake fully applied in spite of any ordinary brake cylinder leakage.

Q. Why do we get only a partial opening of port "N" in the last service notch?

A. This port is purposely restricted in order that main reservoir air may be prevented from passing to the brake cylinders in advance of the auxiliary reservoir pressure, in case the brake valve handle should be moved directly to the last service notch.

Q. When the automatic brake is released by moving the brake valve handle to release position, is the auto-

matic driver and tender brake released and the straight air brake applied?

A. Yes and no. The triple valves are moved to release position and the pressure in the cylinders holding the double check valve seated against the straight air pipe connection commences to escape through the triple valve exhaust. At the same time, straight air at 40 pounds pressure is being admitted to the straight air pipe side of the double check valve. As soon as the pressure in the cylinders falls below 40 pounds, the pressure in the straight air pipe pushes the double check over, closes the connection leading to the triple valve exhaust and raising the brake cylinder pressure back to 40 pounds, holds them applied to that extent.

Q. Is the straight air pressure used at any time in connection with the automatic brake?

A. Yes, the straight air ports are open to the locomotive brake cylinders in the last service notch and the emergency position.

Q. What good does this do?

A. If the pressure in the cylinders, supplied by the automatic brake, falls below 40 pounds, the straight air will hold them applied with that amount of pressure.

Q. If the straight air brake was applied and it became necessary to apply the automatic brake without giving the straight air brake time to release, is there any danger of getting too much pressure in the engine and tender brake cylinders, and overheating or sliding the wheels?

A. No, this is provided for by the lever safety valve.

Q. What is the lever safety valve?

A. A valve placed in the high speed controller in such a way that it is in constant communication with the engine brake cylinders, and permits the brake cylinder

pressure to escape when it builds up beyond a certain predetermined point.

Q. At what pressure is this valve set?

A. At 53 pounds.

Q. Can the locomotive brakes be released without releasing the automatic brakes on train?

A. Yes.

Q. How is this accomplished?

A. By holding down the safety valve lever until all, or as much of the cylinder pressure as may be desired, is allowed to escape.

Q. Where is the air that goes to the brake cylinders in straight air applications taken from with the B-2 brake valve?

A. From chamber "B" above the slide valve.

SCHEDULES.

Q. By what names are the different schedules of this equipment known?

A. B-3, B-3-S, B3-HP and B3-HS.

Q. What is the B-3-S equipment for?

A. For switch engines only.

Q. What are the principal operating parts of the B-3-S equipment?

A. The B-3 brake valve, single pump governor, single pressure controller, lever safety valve, ¾-inch single pressure controller (for straight air), and quick release valve. With this schedule the accelerator valve is not furnished, and the ordinary supplementary reservoir is substituted for the divided reservoir.

Q. At what pressure are the governor and pressure controller valve set with this equipment?

A. The pressure controller is set at 70 pounds, and

the pump governor at 90 pounds for ordinary switching service.

Q. Can an engine, equipped with schedule B-3-S and used in passenger switching service, handle trains charged with high speed pressure without any additional equipment on the engine?

A. Yes, it can.

Q. How is this done?

A. The pump governor would have to be set at 110 pounds pressure, and when handling high speed trains, the ¼-inch cut-out cock, in the pipe between the regulating and supply portions of the pressure controller, closed.

Q. What is the object of closing this cock?

A. It renders the pressure controller inoperative and allows the full main reservoir pressure of 110 pounds to pass to the brake pipe, so that trains using the high speed brake can be handled without delay, and without additional apparatus on the engine.

Q. What is schedule B-3 for?

A. This is a schedule furnished for engines in passenger or freight service, where but one brake pipe pressure is used.

Q. What are the principal operating parts of schedule B-3?

A. The B-3 brake valve, single pump governor, single pressure controller, accelerator valve, divided reservoir, ¾-inch single controller (for straight air), and a lever safety valve.

Q. At what pressures are the governor, and pressure controller adjusted with this schedule?

A. Governor at 90 pounds main reservoir; pressure controller 70 pounds brake pipe.

Q. For what is schedule B3-HP used?

A. For engines in heavy freight service, and heavy grades where loads are handled one way, and empties the other.

Q. What are the principal operating parts of this schedule?

A. The B-3 brake valve, pump governor and pressure controller, each with duplex regulating portions, divided reservoir, accelerator valve, lever safety valve, ¾-inch single pressure controller (for straight air), and union three way cocks.

Q. What brake pipe pressures are usually carried with schedules B 3-HP?

A. The regulating portions of the pressure controller are adjusted for 70 and 90 pounds.

Q. What main reservoir pressures are usually used with this schedule?

A. The regulating portions of the pump governor are set for 90 and 110 pounds respectively. These may be varied, however, to suit local conditions.

Q. How are these pressures cut in and cut out?

A. By three-way cocks provided in the piping.

Q. How are these operated?

A. Turn the handle in line with the pipe leading to the regulating head, set at the pressure to be used, high or low, as desired. This will cut in the head required to regulate the supply portion and cut out the one not required for use.

Q. What is the schedule B3-HS?

A. This is the high speed brake schedule.

Q. What are the principal parts of this schedule?

A. The B-3 brake valve, duplex pump governor, duplex pressure controller, divided reservoir, accelerator

valve, ¾-inch single pressure controller (for straight air), high speed controller, one union three-way cock and one union four-way cock.

Q. At what pressures are the regulating portions of the duplex pressure controller set with this equipment?

A. The low pressure is set at 70 pounds, and the high pressure at 110 pounds.

Q. At what pressures are the regulating portions of the pump governor set, with this schedule?

A. 90 and 130 pounds.

Q. How are the regulating portions of the duplex pressure controller cut in and cut out with this equipment?

A. By means of a four-way cock.

Q. Describe this four-way cock.

A. This is a special cock with a connection to each of the regulating portions, one to the supply pipe between the controller and brake valve, and one to the pipe between the brake valve and accelerator reservoir.

Q. What do the letters "L," "H" and "R," cast on the connections of the union four-way cock signify?

A. "L" stands for low pressure position.

"H" stands for high pressure position.

"R" stands for reservoir, meaning that this connection should be coupled to the accelerator reservoir pipe connection.

Q. What care must be taken in adjusting the regulating portions of the pressure controller?

A. The pressure portion coupled up to the four-way cock connection marked "L," should be set for the low pressure, and the one coupled to the connection marked "H" should be set for the high pressure. Care should also be taken to see that the sides marked "L" and "H"

on the four-way cock lead to the sides of the bracket correspondingly marked.

Q. How is this four-way cock operated?

A. By turning the handle towards the side marked "L" or "H" as required.

Q. What is the purpose of the connection to the accelerator reservoir pipe?

A. To prevent more than the usual predetermined reduction of brake pipe pressure in any graduating notch in a service application with 110 pounds brake pipe pressure.

Q. How is this effected?

A. When the handle of the four-way cock is in position to operate the regulating head adjusted at 110 pounds brake pipe pressure, a small port in the accelerator reservoir connection of the four-way cock is brought into communication with a small port in the four-way cock leading to the atmosphere, which permits a certain quantity of the air passing to the accelerator reservoir to escape to the atmosphere, thus preventing the pressure in the accelerator reservoir rising above the pressure obtained in a service reduction with the low pressure portion cut in.

Q. Why is this port necessary with the high pressure and not with the low?

A. Because the greater velocity of the air at high pressure has a tendency to charge the accelerator reservoir to too high a pressure, and thus cause the accelerator valve to remain open longer than intended.

Q. How are the pump governor regulating heads cut in and out?

A. By means of a union three-way cock having a con-

nection to each of the regulating heads and to the main reservoir pressure.

Q. How is this three-way cock used?

A. The handle is turned to point to the "L" or "H" cast on the cock connections, according to which pressure is desired.

TRAIN HANDLING.

Q. In what position should the handle of the brake valve be, while charging up the train?

A. In running and straight air release position, unless standing on a grade where it might be necessary to hold the train with the straight air brake applied on the locomotive, or in recharging on grades when it is desired to hold the slack of the train bunched, by means of the locomotive brake, while releasing. In either case, the brake valve handle may be placed in release and straight air application position.

Q. How should the brake valve be handled when testing the brakes?

A. It should be moved slowly to the fourth or fifth service notch, and left there until signal is given to release the brakes.

Q. How should the brakes be released?

A. By placing the brake valve handle in running and straight air release position.

Q. In what position should the brake valve handle be placed when the brake is not being operated?

A. In running and straight air release position.

Q. What provision is made to assist the engineer in finding the running position?

A. A small pin projects from the quadrant opposite

the running position notch, so it can be felt by the hand in locating this position in the dark.

Q. In what service notch should the brake valve handle be placed to make a service application of the locomotive and train brakes?

A. In the notch corresponding to the amount of reduction required.

Q. What should govern the initial reduction in making an application?

A. The length of the train, the speed, whether loaded or empty, character of grade and efficiency of the brakes.

Q. When is the first notch of the brake valve used for the initial reduction?

A. Only with short trains of five cars or less.

Q. Why is the exhaust port "G" in the slide valve only partly opened in this position?

A. To prevent the air escaping from the brake pipe fast enough on very short trains, to cause a possibility of undesired quick action of the triple valves.

Q. When is the second notch used?

A. With trains of more than five cars.

Q. What notch should be used for the initial reduction in handling long freight trains down heavy grades?

A. The third notch.

Q. After the initial reduction, how much should the following reductions be?

A. As much as circumstances, in the judgment of the engineer, may indicate as necessary.

Q. How long should the brake valve handle be left in any one position?

A. Ordinarily until a further reduction is required. This valve is supposed to make a brake pipe reduction corresponding to the position placed in, and then to lap

automatically without being moved, and will do so if not defective.

Q. What should be done if it does not lap itself automatically?

A. The handle should be moved slowly back to positive lap position when the desired reduction has been made.

Q. Why necessarily slowly?

A. Because, as previously explained, if the brake pipe is shut off suddenly, there is a tendency for the front brakes to release, which in handling trains, especially long freight trains, might break the train in two.

Q. What is the greatest service reduction obtainable?

A. Twenty-three pounds, in the fifth service notch.

Q. Why is 23 pounds the limit set for the service reduction of the brake pipe?

A. Because, with a reduction of that amount, the pressures in the auxiliary reservoirs and brake cylinders should be equalized.

Q. If, for any reason, a further reduction should be deemed necessary, what could be done?

A. Either return the brake valve handle to lap position, and leave it momentarily, until the exhaust from the back of the piston ceases, then commence again using the notches as if the brake had not been applied at all, or, if desired, move the handle slowly towards emergency position and make the desired reduction by slightly opening the emergency ports.

Q. Would emergency result in this case?

A. No, as the brakes have already been applied practically to full service limit.

Q. In what position should the valve handle be placed to release both the locomotive and train brakes?

A. Running and straight air release position.

Q. If it is desired to release the train brakes only and hold the locomotive brakes applied, what position should be used?

A. The full automatic release and straight air application position.

Q. At what time is this method of releasing brakes particularly beneficial?

A. In releasing the brakes on freight trains, for the purpose of holding the slack bunched, while the train brakes are releasing, also for holding a standing train on grades while recharging.

Q. In releasing the brakes on a grade, should the straight air be held applied long after the automatic brakes are released?

A. No; it, too, should be released.

Q. Why is this?

A. To avoid over-heating the driving-wheel tires.

Q. How should it be released?

A. It should be graduated off, by placing the brake valve handle in running and straight air release position for a moment, and then back to the straight air lap, which is midway between release and running positions, alternately, until fully released.

Q. Why is it necessary to release the straight air gradually, when handling a train?

A. If suddenly released, the engine may surge ahead and cause a severe strain on the draft gear and possibly cause a break-in-two.

Q. How is the brake valve used to apply the straight air locomotive brake only?

A. The handle should be placed in the full release and straight air application position.

Q. Should the straight air brake on the engine be used to bunch the slack of the train before applying the automatic brake, or to stop a train without the use of the automatic brake?

A. As a rule, no,—on account of the liability to cause severe shocks at the rear of the train. If used for this purpose, extreme care must be taken to avoid damage, to cars and lading, caused by the slack running in or out too hard, and it should be graduated on with very light increases of pressure.

Q. How is the straight air graduated on?

A. By placing the brake valve handle in full release and straight air application position for a moment, and then returning it to straight air lap, as previously explained.

Q. If it is desired to release the locomotive brakes without releasing the train brakes, how can it be done?

A. By pressing down the lever of the lever safety valve and holding it down until the locomotive brake is partially, or entirely released, as desired.

Q. When is this particularly beneficial?

A. In case of driving wheels sliding or the tires becoming over-heated.

Q. Does the application of the locomotive brakes in full release and straight air application position affect the train brakes in any manner?

A. No.

Q. In what position only can all the brakes be released?

A. The running and straight air release position.

Q. What is the effect of using the fifth or full service notch of the brake valve?

A. In addition to a full service application of the

automatic brakes, straight air is admitted to the locomotive brake cylinders, and the full pressure, at which the straight air controller is set, will be maintained in them, regardless of brake cylinder leakage and long piston travel.

Q. How is an emergency application of the brakes made?

A. By placing the brake valve handle in full emergency position.

Q. What effect does the use of the emergency position have on the locomotive brakes?

A. In addition to the usual more rapid application of the automatic brakes, the straight air port is open to the brake cylinder pipes in this position also, and the brake cylinder pressure will be maintained, at the pressure at which the straight air controller is set, despite cylinder leakage or piston travel.

Q. If the brakes should be applied in the emergency from an unknown cause, what should be done?

A. Move the brake valve handle over to the last service notch, or the emergency position, and leave it there until the train stops.

Q. What is the object of going to the last service notch or emergency position in this case?

A. To prevent the loss of main reservoir air and to obtain the benefit of the straight air maintenance feature previously explained.

Q. How should the brake valve be handled when making a two-application stop with a passenger train?

A. A heavy application should be made while the speed of the train is high, so as to reduce it rapidly. When it has been reduced to about 10 or 12 miles per hour, if a snort train, place the brake valve in running position just

long enough to start all brakes to release, then return to lap position until ready to make the second application. If the train is a long one, move the brake valve handle to release position for about three seconds, to start the train brakes to release, then to lap position, which will release the locomotive brakes, and leave it there until ready for the second application.

Q. How should the final release of the brakes be made on passenger trains?

A. On short trains, the brakes should be released by moving the handle to running position, just before the train stops. With long trains, the brakes should be held applied until the train stops.

Q. Should the brake valve handle be moved to the full release and straight air application position, after releasing the automatic brakes, to bring the train to a stop?

A. No.

Q. Why not?

A. Because this would be liable to cause severe shocks due to the slack running in against the engine.

Q. Can the full release and straight air application be used when handling a light engine?

A. Yes, if desired, except in cases of emergency, when the emergency application position should be used.

Q. Why?

A. Because a quicker application and a higher brake cylinder pressure would be obtained than is possible by the use of the straight air only.

Q. What should be done if an engine with this equipment is run second in double heading?

A. The double heading cock, in the brake pipe, under the brake valve, should be closed, as with ali previous

types of brake valves, and the brake valve handle placed in running position.

Q. In running trains with two or more engines coupled together, can the engine brakes, on other than the first engine, be used independently of the first engine?

A. Yes, the locomotive brakes of these engines can be applied and released independently of the first engine.

Q. How can this be done?

A. If the automatic brakes are not applied by the leading engine, the straight air brake on any of the following engines and tenders can be applied by placing the brake valve handle in release and straight air application, and release them all by returning the handle to running and straight air release position. If the automatic brakes have been applied on the train, including the helping engines, the engineers on these engines can release the driver and truck brakes, partially or entirely, by using the lever safety valve. They cannot, however, release the automatic tender brakes in this case, as this brake is not connected to the lever safety valve in the cab.

Q. What would cause a continuous blow at the brake valve exhaust in release, running and lap positions?

A. A leak past the vent valve or a leaky main slide valve.

Q. What would cause a leak past this vent valve?

A. Dirt on it or its seat, or the vent valve and seat not ground to make a good joint, either of which permits air to pass to port "O" and through slide valve exhaust to the atmosphere.

Q. What would be the effect of this leak in release, running and lap positions, aside from causing a blow at the brake valve exhaust?

A. As this air is coming from chamber "D," which is supplied by the brake pipe, it is a brake pipe leak.

Q. Would a leaky vent valve have any effect on an automatic application of the brakes?

A Not unless the brake valve handle is returned to positive lap position, when it would cause a leak at the exhaust as before. Except when the brake valve handle is returned to positive lap position, the vent valve is always away from its seat during applications, but air cannot escape by passing the vent valve opening, because in all application positions port "O" is closed to the atmosphere by the slide valve.

Q. What other defect would cause a blow at the brake valve exhaust in release and running position?

A. A leak through the partition of the divided reservoir from the supplementary reservoir to the accelerator reservoir.

Q. How would this leak cause a blow at the brake valve exhaust in release and running positions?

A. Because in these positions, there is a direct opening from the accelerator reservoir through the brake valve to the atmosphere, as well as through port "T" in the accelerator valve.

Q. What might cause a blow at the brake valve exhaust in full release position only?

A. If the slide valve should be badly worn by the graduating valve, it would cause a blow at the exhaust in full release position by being directly over the bridge between chamber "A" and exhaust port "C," and would be a brake pipe leak.

Q. What else, beside the foregoing, could cause a blow in running and lap positions, with brakes not set?

A. In running and lap positions, if the double check is

open to the straight air pipe, a leak past the leather seat on the piston valve side of the high pressure controller.

Q. How could a leak past the seat on the piston valve side of the high speed controller cause a blow at the brake valve exhaust, in running position, and also in lap, if the brake is not applied?

A. Air leaking into the piston valve chamber, unable to escape through the safety valve, would pass into the brake cylinder pipe leading to the double check valve, and if this valve was open to the straight air pipe, would pass up to the brake valve and as the port to straight air pipe is open to the atmosphere, it would escape through brake valve exhaust.

Q. Why would this not cause a blow in lap, if the brake is applied?

A. Because the brake would have to be applied with an automatic application to hold in lap position, and in automatic applications the double check would close the straight air pipe.

Q. Why would it not cause a blow in full release position?

A. Because, on account of the straight air being applied in this position, the straight air pipe exhaust is closed.

Q. How could you determine in a general way whether the trouble was in the slide valve or not?

A. If there is a continuous blow in all positions the trouble would be in the slide valve.

Q. How could you determine, in a general way, if the trouble is in the vent valve?

A. If the valve is tight in all application positions, the trouble is likely in the vent valve.

Q. If the valve only blows in the release and running

positions, how could you tell, in a general way, whether the trouble is in the divided reservoir or the high speed controller?

A. Disconnect the brake cylinder pipe at the high speed controller. If there is a leak from the controller cylinder, piston seat SA-6 is at fault. If there is no leak there, the trouble is likely in the divided reservoir.

Q. What would cause a continuous blow in the positive lap position, with the automatic brake applied?

A. A leaky slide valve, a leaky vent valve, or a leaky double check valve.

Q. How could a leak in the double check valve cause a blow with the brake applied, and the brake valve in positive lap position?

A. There would be a leak into the straight air pipe and as the straight air port is open to the atmosphere in this position, the leakage would escape at the brake valve exhaust.

Q. What would cause a continuous blow at the brake valve exhaust in the different service notches?

A. Failure of the brake valve to lap automatically, a leaky main slide valve, a leaky graduating valve, and in the first four notches, a leaky double check valve.

Q. What would prevent the brake valve from lapping automatically in any of the service notches?

A. A leak to the atmosphere from chamber "D," through the back cap gasket, the pipe connections to the supplementary reservoir, or around the supplementary reservoir, as through a sand hole in the casting, by the reservoir plug, or through the partition of the divided reservoir, due to sand holes, and past the piston packing to chamber "A."

Q. How would leakage past the back head of brake

valve, in pipe connections to supplementary reservoir, or reservoir itself, or through the partition of the divided reservoir, cause this?

A. A leak in any of these places would have the effect of reducing the pressure in chamber "D," and the supplementary reservoir, and when by the movement of the piston, the graduating valve had nearly closed the exhaust port in the slide valve, upon reaching a point where the brake pipe pressure is reducing at the same rate that the pressure in chamber "D" is reducing through leakage at any of the points mentioned, the movement of the graduating valve would cease, and the brake valve refuse to lap itself automatically, and the brake pipe reduction continue until the valve is lapped by hand.

Q. Why does a leak in the piston packing cause the brake valve to fail to lap automatically?

A. For the same reason as given in answer to the preceding question,—only in this case, the supplementary reservoir and chamber "D" air leaks into chamber "A" (brake pipe), past the piston packing, instead of to the atmosphere, as in the preceding case.

Q. What would cause a leak past the piston?

A. A poorly fitted or badly worn packing leather and ring, or a bent piston stem.

Q. How does a bent piston stem cause this?

A. It tends to twist the piston in the cylinder and allow the chamber "D" pressure to leak to the brake pipe.

Q. What causes a piston stem to bend?

A. Probably too frequent use of the emergency position.

Q. What effect would a leak past this piston have with brakes not applied?

A. None at all.

Q. What effect would supplementary reservoir, or chamber "D" leaks to the atmosphere, have with brakes released?

A. Such leaks would, in release and running positions, be supplied from the brake pipe, and being, therefore, brake pipe leaks, would in general simply tend to keep the air pump working.

Q. How could you determine if the failure of the brake valve to lap automatically is caused by supplementary reservoir leaks to the atmosphere?

A. By going over the parts previously mentioned, where air could leak to the atmosphere, with soap suds.

Q. How could you test for leak in partition of divided reservoir?

A. Ordinarily, with brake valve in release or running position, disconnect the pipe leading from the accelerator reservoir to the brake valve, at either end, and see if any air is escaping from the reservoir. If there is a leak, and at the same time, there is considerable leakage from port "T" in the accelerator valve, make the test recommended later on, as there is a possibility of leakage at both places being from the brake pipe, past valve, instead of through the partition of the divided reservoir.

Q. How does a leaky graduating valve cause the brake valve to blow in a service notch the same as if the valve had not lapped automatically?

A. The graduating valve moves to the cut off position, but on account of not making a tight seat on the slide valve, air continues to escape from the brake pipe, which

can only be overcome at the time by lapping the valve by hand.

Q. How would a leak at the double check valve cause a blow at the brake valve exhaust, while the valve is in either of the first four service notches?

A. For the reason previously given, that such leakage would be into the straight air pipe, which is open to the atmosphere in lap and the first four service notches through ports "E," "V" and the brake valve exhaust.

Q. How would you test to determine if it is the double check valve that is causing the blow?

A. With the automatic brake applied, either disconnect the straight air pipe at the brake valve and see if air comes through, or if a special cut-out cock is used in the pipe, close it and see if air comes through the small hole in the side,—in either case it would denote a leaky double check valve.

Q. Is it important that the double check valve be tested occasionally?

A. It is.

Q. Why so?

A. Because, if allowed to become defective, it would allow locomotive brakes to leak off while a service application is being made in any of the first four service notches.

Q. What effect would breaking off the pipe to the supplementary reservoir have?

A. It would prevent the automatic cut-off of the brake valve during a service application.

Q. Why?

A. Because it would reduce the volume of the supplementary reservoir to practically nothing.

Q. What effect would this have on the braking?

A. The brake valve handle would have to be returned to positive lap position following each service reduction.

Q. There being no leaks in the brake valve, what might prevent the reduction in the first service notch being as great as desired?

A. The brake valve handle, or slide valve lever being loose on the handle shaft, or lost motion in the link pins, which connect the slide valve to the slide valve lever.

Q. How would this make the reduction less than intended?

A. Because, when the handle is moved to the first service notch, it would not, on account of the lost motion, move the slide valve as far as intended,—therefore, the air in chamber "D" would not have to expand to the point intended in order to lap the service port in the brake valve.

Q. All parts being tight, what would make the reduction greater in the first service notch, than intended?

A. Lost motion in the graduating valve lever, at the fulcrum pin or at the connections of the piston stem or graduating valve.

Q. How would this cause the reduction to be greater than was intended?

A. Because the piston would have to travel a certain distance to take up this lost motion, without moving the graduating valve, and then moving the graduating valve the usual distance to close the brake valve exhaust, would allow the pressure in chamber "D" to expand lower than was intended.

Q. What is the trouble when the valve laps automatically on an engine alone, or with a short train, but will not with a long train?

A. Leakage past the piston in the brake valve, probably due to a bent piston stem.

Q. Why will the valve lap on an engine alone or with a short train, under these conditions, and not do it on a long train?

A. Where the brake pipe volume is small, it reduces quite rapidly,—giving a correspondingly quick movement to the piston, which carries it and the graduating valve over to the automatic lap in spite of a slight leak, past the piston, but when the volume is large, the piston moves more slowly on account of the slow fall of brake pipe pressure, and if the piston stem is bent on account of it binding in the cylinder, it gives a better opportunity for the pressure in chamber "D" to leak into the brake pipe without moving the piston far enough to have the graduating valve close the exhaust port in the slide valve.

PRESSURE CONTROLLER DEFECTS.

Q. What attention must the vent port "C," in the pressure controller and the straight air controller receive?

A. Special care must always be taken to keep this port open.

Q. When, only, should air escape from it?

A. When the maximum pressure it is set at is obtained.

Q. If air escapes through port "C" before the maximum pressure is reached, what is the trouble?

A. Dirt or scale on seat, or diaphragm does not seat properly on the air valve seat.

Q. If no air passes to the brake pipe at all in first charging up, what is probably the trouble?

A. The cut-out cock between the main reservoir and controller valve may be closed.

Q. If, after charging up all right, the controller failed to open when releasing after an application, what would be the trouble?

A. The piston may be stuck down, or vent port "C" in the muffler plug stopped up.

Q. How could port "C," being stopped up, cause this?

A. If the piston and ring in the supply portion are tight, the air admitted to the top of the piston could not escape, if port "C" should be stopped, except by leaking past the piston and passing out of port "X," which would make the controller very slow to open.

Q. If, at any time and for any reason, the pressure controller refused to open, what could be done?

A. Screw up the hand wheel on the bottom of the controller valve.

Q. What effect would this have?

A. It would allow full main reservoir pressure to pass to the brake pipe.

Q. What precautions should be observed when applying the brakes under these conditions?

A. From any notch under these conditions the brake valve handle should be returned to positive lap position as soon as the safety valve begins to blow.

Q. If the controller should not open promptly after light applications of the brakes, where would the trouble be?

A. This would be due to sluggish action of the controller, which should be reported at once for examination.

Q. What would cause the controller to be sluggish in opening?

A. A continuous leak past the diaphragm and the air valve seat, port "C" plugged up, the piston or ring fitted too tight, or the valve fitted too tight in the valve guide.

Q. What would make the pressure controller sluggish in closing?

A. A bad leak past the piston, passage in the air valve seat partially clogged up, the piston or ring fitted too tightly in the cylinder or the valve fitted too tightly in the guide nut.

Q. What would cause a blow at the relief port "X" in supply portion when the brake pipe is not fully charged up?

A. A leak past the upper seat on the valve, and a loose fitting valve in the guide nut.

Q. What, in addition to this, would cause a blow at this port when fully charged up?

A. Leakage past the piston.

Q. What would cause a continuous blow at the port "C" in the muffler plug?

A. Dirt or scale, or a poor bearing between the diaphragm and air valve seat, and with the high pressure cut in, perhaps a leaky three, or four-way cock in the controlled pipe connections.

Q. What harm would it do to plug this port up in this case?

A. Plugging this port in any case would probably prevent the pressure controller from working, as air could not escape off the piston except by leaking down past it.

Q. What should be done if the pipe to one of the duplex regulating tops should break off?

A. The broken end should be plugged and if it had been connected to the top that was cut in, cut this top

out and cut the other one in, and adjust this one to the pressure being used.

Q. What if the pipe between the supply and regulating portions of the pressure controller should break?

A. It would cut the supply portion off from the regulating portion, and there would be nothing to regulate the brake pipe pressure.

Q. What should be done?

A. Plug the broken pipe to avoid waste of air, and either use the full main reservoir pressure, or cut the main reservoir pressure down to the brake pipe pressure desired, by adjusting the pump governor.

Q. What effect would a leak between the ports in the three-way cock, used in the B-3-HP equipment have?

A. None,—while the low pressure is in use, but if this should be cut out and the high pressure cut in, the air would leak to the low pressure top, but unless the leak is greater than the capacity of port "C," it would not shut the pressure off.

Q. What effect would a leak between the ports in the four-way cock used with Schedule B3-HS have?

A. It would probably cause a constant blow at the accelerator pipe exhaust port, and if the high pressure top was cut in, perhaps at port "C."

LEVER SAFETY VALVE AND HIGH SPEED CONTROLLER DEFECTS.

Q. If there should be a continuous blow at exhaust openings in the spring case of the lever safety valve, either when using the safety valve alone or in connection with the high speed controller, while the brake is applied, where would the trouble be?

A. It would denote a leak past the pop valve seat in

the safety valve, either due to dirt or scale on it or a poor bearing.

Q. What is the trouble if it opens and blows before the brake valve handle is placed in the last service notch?

A. Except when using more than 70 pounds brake pipe pressure, this would indicate that the valve was not properly adjusted, or spring had become weak, or that the piston travel was too short.

Q. What would be the effect of a leak past the seat on the piston valve side of the high speed controller?

A. Brake pipe pressure could leak into the piston valve cylinder and pipes leading to the driver and truck brake cylinders.

Q. What effect would this have with the brakes released?

A. Being unable to escape at the safety valve, the air would travel back to the double check valve, and finding an opening through it, either to the straight air pipe or triple valve, or both, would cause a blow either at the brake valve or triple valve exhaust, or perhaps both.

Q. What effect would this leak have with the brakes applied?

A. In light service applications, it would tend to build the driver and truck brake cylinder pressure up higher than it should be, with the reduction made.

Q. Why should it not do this with a brake pipe pressure of 70 pounds and a full service reduction?

A. Because a full service reduction from 70 pounds would bring the brake pipe pressure down to, if not lower than, that in the brake cylinders, and brake pipe pressure could not leak into a pressure equal to it, or higher.

Q. Why would it raise the cylinder pressure when using the high brake pipe pressure?

A. Because then, the last service notch, when using more than 70 pounds, brake pipe pressure, would still leave the brake pipe pressure higher than 53 pounds, and thus permit a leak from the brake pipe to the locomotive brake cylinders,—if this seat should be very bad.

Q. How could you be sure that the trouble is in this seat?

A. With brakes released, disconnect the brake cylinder pipe from the high speed controller and see if air is blowing from it. If so, the seat on the piston valve side is leaking and must be replaced.

Q. What effect would this defect have if the brake pipe fell below the brake cylinder pressure?

A. None,—as it is the seat on the opposite or plain side of the high speed controller that makes the joint then.

Q. If the brake pipe pressure was reduced lower than the pressure of the engine brake cylinders, and the seat on the plain side of the piston leaked, what would occur?

A. Brake cylinder pressure would leak into the brake pipe and reduce the braking power correspondingly.

Q. How could you test for a leak of this kind?

A. Empty the brake pipe and disconnect the brake pipe from the high speed controller, and see if air blows out of the controller at this point, with brakes applied.

ACCELERATOR VALVE DEFECTS.

Q. If there is a continuous blow at the exhaust elbow of the accelerator valve, what is the trouble?

A. The slide valve is leaking, due to a bad seat or dirt on the seat.

Q. If this leak should be a serious one, what could be done?

A. Cut out the accelerator valve if it has a cut-out cock in the brake pipe connection, if not, put a blind gasket in the brake pipe connection to the accelerator valve, or screw a plug into the exhaust elbow.

Q. If, in making a service application with a light engine, or a short train of less than six cars, there is a blow at the accelerator exhaust elbow, what is the trouble?

A. Either the spring is weak, or port "S" in the piston is plugged up with dirt or gum.

Q. If there is a continuous blow at port "T" in the accelerator valve, what is the cause?

A. Probably a leak past the seat,—due to dirt on seat, or seat being worn.

Q. If this blow only exists when the brake valve handle is in lap position, where would the trouble probably be?

A. A porous wall in the divided reservoir.

Q. If, when using the high speed pressure, the accelerator valve should cause a greater reduction than desired, where would the trouble be?

A. The small exhaust port, in the four-way cock, plugged up.

OTHER DEFECTS.

Q. If there is a continuous blow from exhaust opening "X" in the quick release valve, with the brake applied, what is the trouble?

A. The valve seat is leaking,—due to being in poor condition, or dirt on it.

Q. If there is a blow at the driver brake triple valve

when brakes are either applied or released, what is the trouble?

A. A leaky triple slide valve, due to dirt on the seat, or a defective seat.

Q. If there is a blow at the driver brake triple valve in release only, what is the trouble?

A. A leak past the seat on piston valve side of the high speed controller in all probability.

Q. If it blows only when the straight air brake is applied, what is the trouble?

A. Straight air pressure is leaking past a bad seat on the triple valve side of the double check valve.

QUESTIONS AND ANSWERS.

NEW YORK TYPE J TRIPLE VALVE.

Q. For what conditions of service has the Type J triple valve of the New York air brake company been designed?

A. For all conditions and classes of passenger train service.

Q. How many, and what are the styles in which this valve is made?

A. Two, Style "A," and Style "B."

Q. What is the principal difference between the two styles?

A. Style "A" is fitted with a high emergency pressure cap, safety valve and supplementary reservoir; Style B is not.

Q. What are the main features of the Type J triple valves?

A. The maximum braking pressure is available at all times, provided of course that the air pump is running.

Q. Why is this?

A. Because the auxiliaries are recharged in about the same time required to release the air from brake cylinders.

Q. How many and what are the positions of this valve?

A. Five; as follows: Full release and charging, service, lap, release and recharge, and emergency.

Q. Is there any danger of obtaining an emergency application when making a service application?

A. No. The service ports are so proportioned as to prevent this.

Q. Briefly describe the action of the J triple valve in release and recharge.

A. When brake pipe pressure is restored after a service application, or when the valve is in lap position, the piston, slide valve and graduating valve are returned to full release and recharging position.

Q. Describe the action of the safety valve used in connection with this valve?

A. It is set for 60 pounds, and its action is practically the same as it is with other triple valves.

NEW YORK TYPE K TRIPLE VALVE.

Q. How many, and what are the sizes in which this triple valve is made?

A. Two. The K-5 for 8-inch brake cylinders, and the K-6 for 10-inch brake cylinders.

Q. Do these valves perform all the functions of the older type of quick action triples?

A. Yes; and three additional functions, vix.: quick service, restricted release and uniform recharge.

Q. Can they be used in the same train with the older type of triples?

A. Yes; and they serve to improve the action of the latter when so used.

Q. What is the difference between the K-5 and K-6 triple valves?

A. With the exception of the slide valve, the moving parts in both valves are identical.

Q. For what class of service are the K triple valves well adapted?

A. Long trains.

Q. How many, and what are the positions of this triple valve?

A. Six; as follows: Normal release and recharging, service, service lap, restricted release, normal release after restricted release, and emergency.

Q. When it is desired to make a service application how should the brake valve be handled?

A. Make a gradual reduction of brake pipe pressure.

Q. How is service lap position brought about?

A. By the automatic action of the triple after the desired brake pipe reduction has been made.

Q. If it is desired to make a heavier application how is it obtained?

A. By making a further reduction of brake pipe pressure, which causes the valve to automatically uncover the feed port allowing additional air to pass from the auxiliary to the brake cylinder.

Q. When the auxiliary pressure is reduced below brake pipe pressure, what occurs?

A. The graduating valve will again close the feed port.

Q. Can this action be repeated?

A. It can, until brake pipe and auxiliary pressures equalize.

Q. How is restricted release obtained?

A. By admitting a sufficient volume of air to the brake pipe to cause the parts of the valve to assume a position in which the flow to the atmosphere is limited to one small port.

Q. How is normal release again obtained?

A. When during the time the triple is in restricted release the auxiliary pressure becomes nearly equal to brake pipe pressure, the parts of the valves will again assume the position of normal release.

Q. How is release of the brakes after an emergency application brought about?

A. In the same way as following a service application.

NEW YORK PRESSURE RETAINING VALVES.

Q. How many forms of pressure retaining valves are there in use?

A. There are four.

Q. Which is the most common?

A. The freight car retainer.

Q. What are the other forms?

A. The styles P, PV and DB.

Q. For what are the style P and PV retainers used?

A. For 12, 14 and 16-inch passenger car cylinders.

Q. What is the difference between the style P and the style PV?

A. Style PV has a shaft extended from the retaining plug for the handle, so that the retainer can be located outside of the vestibule and be operated from the inside. Otherwise they are alike.

Q. Why is it necessary to use a special pressure retainer on passenger cars having 12-inch or larger brake cylinders?

A. As the style S triple valve used on 12, 14 and 16-inch cylinders has a larger exhaust port than the smaller triples, it was necessary to make the retainer larger to correspond in order to reduce the pressure from the larger brake cylinders as fast as the smaller pressure retainer did from the smaller cylinders.

Q. Where are the retaining valves usually located?

A. They are placed at points about the cars and locomotive, easily accessible by trainmen and enginemen, where they may be conveniently operated.

On freight cars they are usually located close to the hand brake; on passenger cars, at the end and inside of vestibule; and on locomotives inside the cab and on the tender; near the gangway.

Q. How are the retaining valves piped?

A. They are piped to the exhaust port of the triple valve, so that when the triple valve goes to release position, the exhaust air from the brake cylinder must pass through this pipe to the pressure retaining valve before it can escape to the atmosphere.

Q. Where are pressure retaining valves mostly used?

A. In mountain service to assist in letting trains down grades safely.

Q. How do they operate to increase the facility and safety of train handling?

A. In mountain service, when the engineer desires to recharge the auxiliaries without allowing the train speed to increase materially, they retard the exhaust of air from the brake cylinder until the pressure reduces to about 15 pounds, and then retain this latter amount. To do this, however, the pressure-retaining valve handle must be turned to a horizontal position.

In level grade service, pressure retaining valves are used to advantage in holding the slack bunched in long trains while releasing the automatic brakes, to prevent breaking in two.

Q. If the handle of the freight car retainer is turned up to a horizontal position, how much pressure will it hold, or retain, in the brake cylinder?

A. About 15 pounds.

Q. Does the passenger car retainer hold the same amount of pressure?

A. Yes.

Q. With a freight car retainer handle turned up, how long should it take the brake cylinder pressure to blow down to 15 pounds from 50 pounds, with 8-inch piston travel and an 8-inch cylinder?

A. About 58 seconds.

Q. How long will it take to blow down under the same conditions with a 10-inch passenger car cylinder; 14-inch; 16-inch?

A. About 62 seconds.

Q. When freight car pressure retainers are used on 14-inch brake cylinders, on long trains, where there are cars without retainers, what is the result in making the stop even though these retainers are not turned up?

A. It is almost impossible to make the stop without a shock, and possibly breaking in two. The cars which have no retainers will have their brakes released before those which have retainers.

Q. When a small retainer is used on cars that have large brake cylinders, and the retainer is turned up on a long grade, what is likely to occur?

A. As the retainers take longer to blow the pressure down, the wheels are likely to overheat.

Q. Where is the style DB retainer used?

A. On driver brake cylinders, for the purpose of holding the driver brakes applied while releasing the train brakes.

Q. Why is it desirable to operate retainers on driver brakes?

A. To keep the train bunched while releasing at slow speeds, and thus prevent it from breaking away into two or more pieces.

Q. How many positions are there for the handle of the DB style retainer?

A. Three; vertically downward, full release; horizontal, to retain 15 pounds; vertically upward, to retain all brake cylinder pressure.

Q. In order to have the pressure retaining valve operate efficiently, what conditions must be observed?

A. The pressure retaining pipe and all the joints must be absolutely air tight, as must also be the brake cylinder packing leather.

BRAKE LEVERAGE.

Q. What is understood by the term "leverage?"

A. When taken in connection with car braking, it is a combination or system of levers, so coupled up and arranged, that when actuated by the brake piston pressure, delivers pressure on the brake shoes to arrest the rotation of the wheels.

Q. Are levers always used in combination in air brake work?

A. Yes; generally speaking, but in the study of leverage, it is found advantageous to divide up the combination and treat each lever therein as a single, simple lever.

Q. How many kinds of levers are used in modern air brake pactice?

A. Three. They are known as levers of the first class, second class and third class.

Q. What is the difference between these three classes of levers?

A. The location of the three points in the lever at which the application of the forces is made determines the class of the lever.

Q. Describe a lever of the first class.

A. It is a lever in which the fulcrum point is between the points where force is applied, and force delivered.

Q. What is a lever of the second class?

A. One in which the point where force is delivered is between the fulcrum and the point where force is applied.

Q. Describe a lever of the third class.

A. In a lever of the third class the point where force is applied is between the fulcrum and the force delivered point.

Q. What is meant by the proportion of levers?

A. The ability of the lever to deliver a certain force in proportion to the force applied upon it.

Q. How is the proportion of a lever found?

A. By dividing the force-applied arm by the force-delivered arm.

Q. What is the force-applied arm?

A. The length in inches of that portion of the lever lying between the force-applied point and the fulcrum point.

Q. What is the force-delivered arm?

A. That portion of the lever in inches between the force-delivered point and fulcrum point.

Q. Give a formula for calculating the force in pounds delivered by a lever.

A. $W = \dfrac{F \times a}{b}$ in which W is the unknown quantity (viz.: force delivered); F is the force applied in pounds; a equals distance in inches between force applied point, and fulcrum point, b equals distance in inches between fulcrum point and force-delivered point.

Q. Give method of calculation.

A. F multiplied by a, and this product divided by b, all

of which are known quantities, will equal W, the force delivered.

Q. Explain the formula, $F = \dfrac{W \times b}{a}$

A. In this formula the value of F is to be ascertained; therefore, W multiplied by b, and this product divided by a, all of which are known quantities, will equal F, the force applied.

Q. Is there not a general rule which can be used, disregarding the class of the lever?

A. Yes, it is very simple, worth memorizing, and is as follows: Multiply the force applied by the force-applied arm, in inches, and divide that product by the force-delivered arm, in inches.

Q. What is meant by force-applied point?

A. That point on the lever where the pressure, or power, is first introduced.

Q. What is meant by the force-delivered point of the lever?

A. That point of the lever where the force practically leaves the lever, through the connecting rod, to proceed to the next connecting lever.

Q. What is meant by the fulcrum point of the lever?

A. That point which is practically used as a stationary point on which the lever gets its purchase, or, as is commonly known, gets its "prying" point.

TOTAL LEVERAGE.

Q. What is meant by total leverage?

A. Total leverage, in the continuous combination of brake leverage in the foundation brake gear of a car, is an

equivalent to one single, long lever, if it were possible to use such a lever; but, on account of the inability to do so, a series of several shorter, or lower proportioned levers must be employed and be connected up into a system to produce the same result that one very long lever would.

Q. What is meant by a total leverage of 7 to 1?

A. In car leverage it means that a system of short levers used in combination is capable of delivering a pressure at the brake shoes seven times greater than that applied by piston in the brake cylinder.

Q. About what should the total leverage on a car be?

A. Never higher than 10 to 1, and if possible, as low as 7 or 8 to 1.

Q. Why are these limits placed on the total leverage?

A. On account of the very small clearance between the brake shoes and wheels, and to prevent rubbing of the brake shoes on the wheels when brakes are released.

BRAKING POWER.

Q. What is meant by the term "braking power?"

A. The power applied at the brake shoes, through the medium of the leverage and the pressure on the air piston, to arrest the rotation of the wheels.

Q. What is meant by braking power per pair of wheels?

A. The pressure delivered by the brake shoes on one pair of wheels.

Q. What is meant by total braking power?

A. The total pressure expended on all the wheels of the car.

BRAKING POWER PERCENTAGE.

Q. What is meant by percentage of braking power?

A. The ratio of the total braking power and the total weight of the car. This percentage is found by dividing the total braking power by the weight of the car.

Q. What percentage of braking power is ordinarily employed?

A. On passenger cars, 90 per cent; on freight cars, 70 per cent; on tenders, 100 per cent; on locomotive driving wheels, 75 per cent; on engine truck wheels, 75 per cent.

Q. Is the percentage of braking power based on the light or loaded weight of the car, tender and engine.

A. It is based on the light weight of the passenger car, freight car and tender; but is based on the loaded weight resting on the locomotive driving wheels and on the truck brake wheels.

Q. Why is the braking power based on the light weight of the car and tender and on the loaded weight of the engine?

A. The higher percentage of braking power on the passenger car is designed because the loaded weight and light weight of the car do not vary a great deal; hence, a high braking power is permissible. The freight car varies greatly between its light and loaded weight; hence, the braking power must be placed lower than with the passenger car. Also the freight car runs at lower speeds, where the co-efficient of brake shoe friction is higher than on the passenger car at high speeds, and a lower braking power must therefore be used, to prevent the skidding of wheels when the car is empty.

Q. Why is 75 per cent used on the engine driving wheel and truck wheel brakes?

A. The weight of the engine in working order does not vary much, and the working weight is really the loaded weight; hence, the braking power of the engine is comparatively high, although it may seem low when we consider the figures only.

Q. Why is the tender braked at 100 per cent?

A. Because it has been found that this percentage can be safely used, on account of the tender always carrying a certain amount of coal and water above the light weight.

Q. How have these practices been determined and adopted?

A. By actual service conditions.

Q. Is there a different percentage in braking power on a car when it is loaded and when it is light?

A. Yes; if a car is braked 70 per cent, and be given a load equal to its own weight, the car will be then braking at only 35 per cent.

Q. What cylinder pressure is used as a basis for computing the braking power?

A. Sixty pounds where the quick action triple valve is used, and 50 pounds when the plain triple is used.

Q. How is the piston pressure in the cylinder calculated?

A. The diameter of the piston is first multiplied by itself, then that product multiplied by the decimal .7854 and that product in turn multiplied by the pressure exerted in pounds per square inch on the piston. Thus, the calculation of a 60-pound pressure on the piston of an 8-inch cylinder would result as follows:

$8 \times 8 = 64$; $64 \times .7854 = 50$; $50 \times 60 = 3000$ lbs.

Q. What is understood by the term "foundation brake gear?"

A. That part of the air brake system under the car, comprising the levers, connecting rods, jaws, pins, brake beams, hangers, hanger supports, lever guides and supports.

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